Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA.

VOL. XXXVII. No. 12. NEW YORK, WEDNESDAY, SEPTEMBER 19, 1900. ISSUED WEEKLY.

ELECTRICAL REVIEW

Park Row Building,
13-21 Park Row, New York.
P. O. Box 2339.

CHARLES W. PRICE, Editor.
STEPHEN L. COLES, Managing Editor.
CHARLES T. CHILD, Technical Editor.
STEPHEN H. GODDARD, Advertising Manager.
RUSSELL HOWLAND, Assistant Advertising Manager.

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Telephone Call, 21 "Cortlandt."
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Subscriptions to the
ELECTRICAL REVIEW.

One Year, United States and Canada, - - $3.00
One Year, Foreign Countries, - - - - - - 5.00
Single Copies, each, - - - - - - - - .10
Copies can be supplied for only one year back at 25 cents each.

THE NERNST LAMP.

Since the date of the invention of the incandescent lamp attempts to improve its efficiency—that is its output of light in proportion to its absorption of electrical energy—have been made in many ways and the modern incandescent lamp is about twice as efficient as the early types put on the market in commercial form. It has long been realized that an increase in the efficiency of the translating device must be the next great step in electric light engineering, since the efficiency of the production of electric current from mechanical power has attained a point which leaves little to be desired. The beautiful invention of Dr. Nernst was on this account hailed with the greatest acclaim by the electrical field at large and the commercial form of his lamp has been awaited with impatience and the deepest interest. On another page of this issue will be found a fully illustrated description of the Nernst lamps on exhibition at the Paris Exposition. The principal of these lamps, as is well known, is that certain metallic oxides which are normally non-conductors become, at high temperatures, bad conductors of the electrolytic type, and under such circumstances when permeated by a powerful current of electricity become intensely hot, glowing with a steady white and powerful light. Since the temperature of these oxides can be carried to a very elevated point, and since their radiating power is such as to make their surface intensity of illumination greater than that of carbon at a similar temperature, these lamps have shown remarkable efficiency and hold out high promise of future perfection and adaptability. Unfortunately, they have to be warmed up in order to be lighted, and this introduces a complexity in the construction of the lamp itself, requiring a heating coil in connection with the filament, or else the use of a match or flame to bring the incandescing body up to the requisite temperature to make it a conductor of electricity. It is not unreasonable to suppose that the slight complexity introduced by the heat coil will be greatly improved in future designs of the lamp, and there is no doubt whatever that there is at present a commercial demand for lamps of candle-power intermediate between that of the ordinary incandescent lamp and the enclosed arc. Into this field the Nernst lamp will probably come in the near future. Its invention is illustrative of the important truth which should never be lost sight of, that any physical fact that may be discovered, whether apparently of importance or not, is worth all the labor that its discovery costs, because no one can foresee at what time it may become of commercial and industrial value.

The reconstruction of the Broadway cable line in New York city and its conversion into an electric railway is, to-day, something that attracts little attention; five years ago it would have been regarded as an epoch-marking event; ten years ago it would have been an impossibility. So fast has the progress of electric traction been that we now regard the conversion of the most important existing cable railway in the world into an electric road as quite the ordinary and expected thing. It is noteworthy, notwithstanding, that the last prominent cable line in the United States is being converted—the busiest street railway in the world it is, also—and that on it the cable replaced the horse only eight years ago.

On another page of this issue is given, practically in full, the text of the decision lately rendered by Judge Townsend, of the United States Circuit Court, in a suit alleging infringement of the patents granted to Mr. Nikola Tesla, upon the polyphase system of electrical transmission of power. The opinion reflects no little credit upon the learned judge's knowledge of electro-technical subjects. Whatever may be the history of the development of the polyphase system, there is no doubt that it has done more than any other single invention in the field of electrotechnics in the last fifteen years to advance and make possible the greater exploitation of electrical industries that we see about us to-day. The recognition given by Judge Townsend to Mr. Tesla is one that must be gratifying to him, and the text of the opinion, even to those not interested in the particular features of the matter in litigation, will be of peculiar interest as bearing upon the importance of the newer applications of the alternating current.

RUBBER AND GUTTA-PERCHA SUBSTITUTES.

There seems to be a large demand at present for substitutes for gutta-percha and rubber for use in insulating and for other applications in the electrical arts. The search for a substitute for, or, perhaps, for a method of manufacturing, gutta-percha or rubber synthetically is progressing at an accelerated rate, and new compounds, many of them of great value, are constantly being brought forward and placed upon the market. So far nothing has been found that can supplant gutta-percha for submarine cable insulation, nor has any perfectly satisfactory substitute for rubber been found, though several of the compounds that have been brought out come very close in their properties to the original gum. We have seen so much of the extraordinary ability of the modern chemist to make organic compounds by synthesis that there should be no fear felt that india-rubber and gutta-percha will prove beyond his skill. To-day, many substances of original organic origin are manufactured in the laboratory, among them notably many that it was considered impossible ever to find a substitute for, or to construct except in the natural laboratory of the vegetable or animal cell. Such a substance is quinine, which is now manufactured in enormous quantities, practically no natural quinine being on the market to-day. The flavors of fruits and the colors of vegetable dyes are to-day made from gas-tar products and their manufacture is an important industry. Looking at these facts it does not seem unreasonable to hope for the synthesis of rubber and gutta-percha, and all alarm about the disappearance of the natural sources of these materials should be allayed by their possible manufacture from other components in the laboratory and the workshop.

The astonishing performance of the two new British torpedo destroyers, Viper and Cobra, has called renewed attention to the availability of the steam turbine in large sizes for electrical generation. It is hard to understand why this machine should have been so little recognized as it has been for this use. For the driving of alternating current and polyphase machinery its rotary motion gives it an advantage over any form of reciprocating engine, whether gas or steam driven. It has lately been shown that by the use of a moderate degree of superheat in the steam supplied to it an extraordinary efficiency of operation can be secured, and this coupled with reasonable cost, light weight, small size and absence of vibration, seem to make it ideal for the driving of dynamos. It is true that the high speed at which the steam turbine normally runs makes it impossible to couple it directly to dynamos of the ordinary type, but one has only to remember the dynamo of ten years ago adapted for high-speed operation to recall the perfect ability of constructors to build machines, working with good efficiency and satisfactory output, on higher rotational speeds than those at present commonly in use. Now that the inductor type or the rotating field type of alternating-current generator is coming into general use there is no doubt that the makers of such machines would welcome a motive-power apparatus running normally at higher speeds than those of the reciprocating engine. It is not unreasonable to look forward to generating stations in the near future equipped with inductor alternators direct coupled to steam turbines, running silently and without vibration at high speeds and with great economy, the whole mechanism of the station being confined in much less space and requiring much less attendance than a station of similar output necessarily must have to-day.

The interesting article by Mr. Alton D. Adams on another page, calling attention to the waste of energy in electric light stations and the possibilities of saving by the combination of electrical supply stations and gas works, is one that is well worth the careful consideration of both gas and electrical engineers. There can be no doubt that the gas engine is rapidly coming to the front as a serious competitor of the steam engine for large powers. Perhaps the one thing that was prominent in the mechanical section of the Paris Exposition was this fact. While recognizing the enormous difficulty of constructing gas engines of large powers it must not be forgotten that the thermal efficiency of these machines is far more than that of the steam engine, and that under proper conditions they may be made to develop nearly as much power per pound of combustible burned as the older type of prime motor. How far these facts will bear upon the design of electric light stations in the future it is not at present possible to determine but there seems little doubt that some time a combination will be made between gas supply, electricity supply and steam-heat supply stations—possibly combined with ice plants for operation in the Summer—that will result in an over-all efficiency of operation and production superior to anything that is at present in sight.

From the office windows of the ELECTRICAL REVIEW a dozen lines of steam ferry boats plying across the North River between New York city and Jersey City are visible. It is a painful sight to the electrical engineer who contemplates the extraordinary improvement in the service of these vessels and in the economy of their operation that could be made by converting them into electric boats driven by storage batteries and charged in their slips, or else by engines and generators of relatively small power on board working continuously throughout the whole time of operation of the boats. The subject is too old to require elaborate explanation here. The advantages of such boats are indisputable and in no place in the world are the conditions of service so perfect and so well adapted for the operation of electric boats as they are in the two crowded and busy rivers intersecting greater New York. Perhaps some day the natural inborn conservatism of the railroad managements controlling the majority of the ferry lines will move, and one of them will try the experiment of a storage battery boat. There is no doubt about the outcome of it, nor of the satisfaction that passengers will enjoy from a flush-deck boat with no engine-space in the middle of it and with no noxious, ill-smelling or hot machinery on board.

ELECTRIC, GAS AND HEATING PLANTS.

BY ALTON D. ADAMS.

Electrical machinery has reached a state of development that leaves little to be expected or desired as to efficiency. Systems of distribution have been improved until a single large station serves territory within a radius of some miles, with a loss of less than 10 per cent between the main dynamos and consumers. In spite of these advances, the cost of electrical energy remains high; so high that the public endure coal oil or gas light to a large extent, instead of enjoying electric lamps.

The technical problems of electric generation and distribution have been well solved, but the financial problem of cheap electrical supply to the great majorities in cities has had comparatively little attention. Electrical energy has been sold for not more than, and too frequently for less than, a fair profit on its cost, but the energy sold is not more than one-tenth of that developed at the station. While the refinements of engineering have been applied to obtain an increase of even one per cent in the efficiency of electric machinery and systems, nearly 90 per cent of the energy available at central stations has been recklessly discarded.

At the present time the rapid increase in the capacity and outputs of electric station, compared with the population, has largely subsided. The proportion in amount between the electric and other forms of illumination has become nearly a fixed quantity. It is, then fair to ask whether electric stations have reached their final and correct proportions relative to population? The answer to this question depends on costs and prices. Only a fraction of those who prefer electric light have it, but as many have it as will pay the present rates.

If present prices of electric energy are as low as can be expected, the majority are permanently debarred from its use. That the current charges for electric energy, from central stations which derive their entire income from its sale, can be materially reduced, finds small warrant in existing facts. The present revenues of electric stations can only be cut down as expenses are reduced, but where can a material reduction of operating expenses be made? The item of labor has already been cut to nearly its minimum. Boilers deliver 80 per cent of the total fuel energy to steam, and steam engines, operating within their possible range of temperature, have reached nearly the maximum limit of their low efficiency. Gas engines promise some improvement over those using steam as to efficiency, but even they allow three-fourths of the heat from fuel to escape without doing any useful work.

Steam turbines seem able to diminish the weight and cost of electric generating equipment through higher speeds, but the same iron law as to temperature range limits their possible economy. As far as can now be seen, electric energy from dynamos must remain only a trifling part of that in the fuel consumed, so long as a heat engine remains the prime mover. There is apparently no escape from the conclusion that by far the most important reduction in the cost of electric energy, and, therefore, in its selling price, is to be made by the utilization of the waste heat at central stations. So long as 90 per cent of the energy in coal is wasted, the selling price of the remaining 10 per cent must remain comparatively high. When much the greater part of the heat, that now is lost at central stations, is applied to some useful purpose, the return, not only per ton of coal burned, but also on each dollar invested in plant and equipment, will be materially increased.

Electric plants are not alone as to low efficiency in the application of fuel energy to public wants. Gas works, the strongest competitors—though they should be the firmest allies—of electric systems, also make a poor showing in the ratio of delivered energy to their fuel heat. Good gas coal yields as much as one-fourth of its total calorific power in gas. Coke, equivalent to 15 per cent of the coal treated, is consumed under the gas ovens, and this, with losses incident to the process, reduces the available coke to one half of the heating power of the coal used. Simple coal gas has excellent heating properties, about 650 heat units per cubic foot, or 6,500,000 units in the 10,000 cubic feet of gas yielded by one ton of coal. The illuminating power of this gas, however, is only moderate, ranging from 13 to 16 candle-power in the open flame burner that consumes five cubic feet per hour.

The color of light from the open flame of pure coal gas is so yellow that it compares very unfavorably with the white light of incandescent lamps. To improve the position of gas as a competitor in the field with electric light, resort is had to the use of enrichers. Petroleum and its products are largely employed to increase the candle-power and change the color of the open gas flame. It was soon found, however, that simple coal gas could receive very little enrichment with petroleum without becoming smoky. Hence the development and introduction of water gas.

Commercial, carburretted gas, as now distributed in most large cities, is either pure water gas treated with petroleum, or a mixture of coal and water gas so treated. For water-gas production, anthracite coal or coke is necessary. The efficiency of water-gas manufacture is decidedly inferior to that of coal gas. Coke and gas, as net products of the coal-gas process, contain 75 per cent of the calorific energy of the fuel consumed. Water gas yields 40 per cent of the heating power of the total coal or coke necessary for the generators and under boilers to make the required steam. The efficiency of a carburretted water-gas plant as to its coal or coke is thus 40 per cent, while works that produce a mixture of coal and water gas, using coke from the retorts in the water-gas generators, show an efficiency as to coal of about 45 per cent. Water gas can be enriched with petroleum to a much higher candle-power than simple coal gas, without development of the smoky tendency, and the efficiency of gas production from coal is thus materially reduced in order to strengthen its position in the field of illumination, where it is at best a poor second to the electric lamp.

Since the development of electrical distribution on an extensive scale it has grown more and more apparent that the true economic position of gas for public supply is that of a heating agent in cooking and manufacturing operations, the development of power in comparatively large units for a limited number of cases, and a greatly reduced amount of lighting, using incandescent mantles, especially out of doors. When gas and electric supply interests in any city come under a unity of management, their future intelligent development may be expected to proceed along these lines, but the desirable adjustment of service between the two agents can not even then be reached as long as the electric plant rejects, as useless, 90 per cent of its fuel energy. In combined gas and electric plants, simple coal gas will be generated and distributed without enrichment, and the resulting coke, instead of undergoing reduction to water gas, to contain only 40 per cent of its energy, will transfer 80 per cent of its heat to steam. The simple coal gas thus produced can be sold at a profit for a much lower price than that now charged for carburretted water gas, while the coal gas contains 85 to 90 per cent of the heating power of the latter. Illuminating power of the coal gas will be below the present standard if used at the open flame, but its

lower price will work a large extension to cooking and manufacturing purposes. Where the coal gas must be used for illumination, better results can be obtained with incandescent mantles that depend simply on the amount of applied heat, than the best carburretted water gas can give at the open flame. The cost of incandescent mantles and the inconvenience attendant upon their use will tend to a decided increase in the demand for electric light, and, if this demand is encouraged, as it may be, by reduction in the charges for electric energy, the result will be a great extension of electrical supply.

With coke from the gas retorts as not only a cheap but a smokeless fuel, electric stations will have a decided increase over present advantages by the change in their practicable locations. Smoke nuisance and the cost of the removal of ashes are two of the arguments against the location of electric stations near the areas they serve, and the value of storage room for coal in the business districts is a third. These three arguments fail when coke produced and stored at an outlying gas works is burned in one or more electric plants centrally located. On this matter of location largely turns the question of a greatly increased efficiency for the electric station between its steam boilers and consumers. The great loss of energy at public electric plants appears as heat, and as heat it must be utilized, if at all. When a station is central in location as well as in name, most of that heat that would otherwise be wasted can be sold to warm buildings during more than one-half of each year. In addition, enough heat can usually be sold directly from the boilers to largely extend the time of their productive use during each 24 hours. Distance is the greatest impediment to the distribution of heat from electric stations, and the location of such stations in the midst of their surface areas makes the distribution of the heat of exhaust steam entirely practicable. Heat loss from distribution pipes necessarily increases with their length, but need not exceed one-fourth of the amount entering them for distances up to one mile from the station. Two systems of heat supply from central stations are available—one with steam, the other by hot water. The former has been applied in the greater number of cases, but the latter is better adapted to the conditions that exist at electric stations, especially where the radius of operation is much greater than one-fourth mile. By the addition of a heating system an electric station may increase its efficiency as to the portion of fuel energy delivered to consumers to 50 or 60 per cent instead of the 10 per cent of present practice. The sale of five or six times the present amounts of energy from electric stations, from the same coal consumption and boiler equipment, will obviously make a reduction in the charges for electric light and the consequent increase of output an advantage to the central station as well as to consumers. The force of this last fact is better understood when it is considered that the exhaust of engines will only heat one-fifth to one-tenth of the building space that the dynamo they operate will supply with light. True, building heat is only wanted during little more than one-half of each year, but heat can be put to productive purposes at stations the remaining time.

ELECTROSTATIC ROTATION—VII.

BY ALFRED G. DELL.

In the following article I will give some further experiments made with the rotating disks described in former articles where sparks from the secondary of an induction coil are passing under the disks.

I will first describe more fully the effects from humidity in the air on rotations of such disks. I found that slight rotations from positive to negative would commence when the humidity was 50, and when it went as low as 42 per cent, I obtained good rotations both ways, the starting velocity from negative to positive was then small. Above 50 per cent humidity, there was little, if any, rotation; as much as 60 per cent the disks would not rotate. When the humidity was between 70 and 80, they acted very indifferently, it appeared as if the disks had become conductors to a small extent from the moisture collected on them.

From the rotations I was able for a while to tell the humidity within a small per cent, providing it was not above 60. As a final resort to obtain rotations in all kinds of weather, I placed the disks in boxes with glass sides, each box about six inches square with a small glass tube passing through one side of each box, with a piece of hollow rubber on the end on the outside, so I could change the rotation direction by pressing it.

I dried all moisture off of a disk, and placed it in the box (the box in this case was not heated) with some calcium chloride, the disk used in this case was the one swung by magnetism. The humidity, when placed in the box was 67. It would not rotate at first, but after the calcium chloride had remained in it for several days, it rotated both ways nicely. I had to give the axle and piece of steel to which the disk was suspended, an extra amount of magnetism to prevent its falling off from any slight jars. I moved the box, and the axle of the disk slipped to one side, and I could not get it back in place without opening the box, so I had to fall back on the arrangements containing jeweled bearings. I found I could obtain rotations sooner by driving out the moisture with heat, while with the calcium chloride alone I had to wait for some time. The following I regard as an important new experiment. I never noticed it until I got to using the boxes, as I always kept the electrodes bright, when used in the open air. When the same electrodes had been used for some time, and not cleaned, if the primary current of the induction coil was reversed, the disk used would start and rotate always in the same direction it did before the current had been reversed; of course, if started in an opposite direction it would rotate in that direction. The reason of such action I am quite sure is the following: The negative point becomes more tarnished than the positive, and when the current is reversed, the extra tarnishing of the former negative point offers more resistance to the discharges of the new positive than the old positive did.

I really do not think a coil when run in one direction for a long time should be reversed at all, but the wires changed, if discharges are wanted in the other direction.

I made two of the boxes described above, with the separate disk arrangements; the electrodes of one I made exactly alike in every respect as to size and shape, and obtained exactly the same results as with the others, in the experiments described, and in all former articles on this subject.

The heat effects are of some little account. When the arrangements are heated to drive out the moisture, the disks will not rotate quite as well. I had to let them cool off some before obtaining a good rotation both ways. The heat from the weather is the same, but of small account; with 94 degrees in the room they rotated all right, but not quite as rapidly as when cool. Expansion of the axles, and softening of the shellac, I think, is the cause, and not any direct action on the discharges.

I made one disk with a long, thin axle, and obtained fair rotations; I then added another disk above the one next the cardboard, and let the sparks pass between the two disks, with which I obtained an increased rotation over the single one when on the long axle alone.

The following experiment, I think, is of some little importance: I attached one of the electrodes of a disk arrangement to the positive side of a small coil, and with a ground arranged, so I could connect and disconnect the negative end of the small coil. I found there was a very decided increase in the rotation when the ground was connected, over that when it was disconnected, showing the discharges from the positive electrode of a coil, when not allowed to spark from one electrode to the other, are increased if the negative is connected to earth.

THE NERNST LAMP IN COMMERCIAL FORM AT THE PARIS EXPOSITION.

BY C. L. DURAND.

One of the novelties at the Paris Exposition is the exhibit of the Nernst lamp, which is now being manufactured by the Allgemeine Electric Company, one of the largest of the German electrical firms, with which Professor Nernst is connected. The company started a series of experiments to bring the lamp into practical shape very shortly after the discovery of Professor Nernst was made known, by which he proved that certain refractory substances became conductors when strongly heated, and could be raised to incandescence upon the passage of a current. Before bringing the lamp to its present state, however, a long series of experiments was necessary to overcome the numerous practical difficulties which presented themselves. The company is now making the lamp upon a commercial scale, and it will soon increase its lamp factories in order to turn out a considerable quantity.

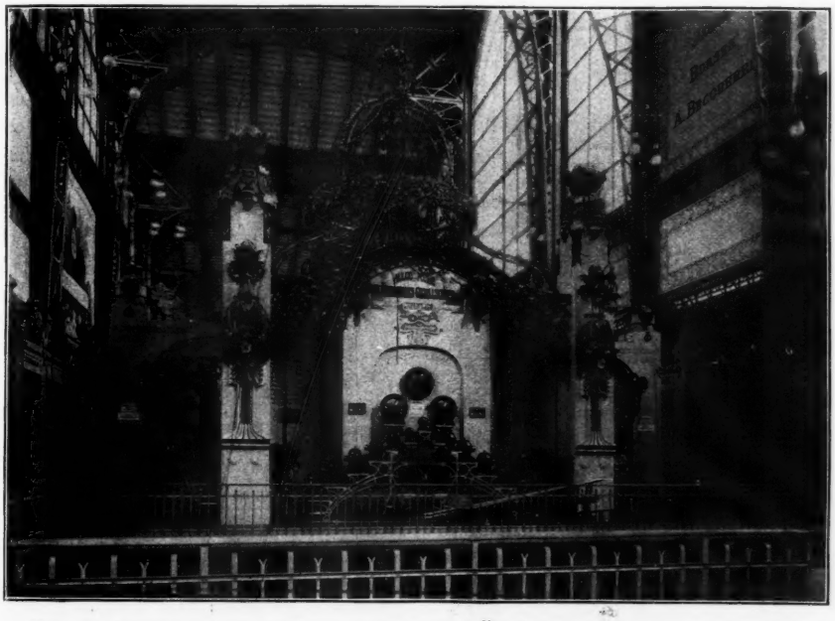


FIG. 1.—EXHIBIT OF THE ALLGEMEINE ELEKTRICITÄTS GESELLSCHAFT AT THE PARIS EXPOSITION.

The ideas of Professor Nernst upon the subject are well expressed in an address which he delivered some time since in Göttingen, where he has his laboratory and is at present conducting further experiments. After mentioning the early experiments of Jablochkoff, in which small pieces of kaolin were heated between two carbons and raised to incandescence, he continues as follows: "The superiority of the luminous effect of the arc lamp comes from the fact that the carbon is raised to a much higher temperature, such that the filament of an incandescent lamp could not support. But as in practice it is scarcely possible to raise the temperature of the electric lamps used at the present time, there is little hope of increasing the luminous effect; great progress could be made if it were possible to use as the incandescent body a substance which would emit but a small proportion of calorific rays and with which nearly all the energy could be transformed into light. It is evident to me that it is hardly possible to find a substance of this kind in a metallic conductor or a combination of metallic or mineral matter. All the opaque bodies, according to the principle of Kirchoff, emit more calorific than luminous rays, and furnish, in fact, what is called the normal spectrum of a black body. Besides, according to the electro-magnetic theory of light, it is necessary that electro-magnetic conductors should be opaque; thus with metallic compounds it is not possible to construct a very economical lamp; at least, if it is not worked at the temperature of the arc or even higher. The production of light in a gas flame presents a certain analogy with the problem in question; as long as the transmission of light is brought about by molecules of carbon, the process is accompanied by great losses in calorific rays. The replacing of the gas flame by a substance furnishing the normal spectrum, like the Welsbach burner, was a great step in advance. The consideration of the action taking place in this burner led me to the solution of the present form of incandescent lamp. As it sufficed for the Welsbach burner to introduce it into a gas flame in order to raise it to a very high temperature, and, consequently, a great lighting power; in the present case it was necessary to heat magnesia and other substances by the electric current to produce the same effect. But the great insulating properties of these bodies prevents the current from passing; the use of high-tension sparks to heat to whiteness the refractory bodies, according to the method proposed by Jablochkoff, is not available in practice. On the other hand, it is well known that the oxides and electrolytes, when in fusion, conduct the current in a great degree.

"The experiments of Van t'Hoff, made a few years ago upon what he called 'solid fusion,' led me to suppose the existence of solid electrolytes having a sufficient conducting power, and by some preliminary trials, I was able to establish that mixtures of oxides and other bodies, for instance, magnesia and porcelain, became very good conductors at high temperatures; it was to be considered that the electrolytic decomposed chemically by the action of the current, and it might be found that the passage of the current would in time cause deterioration of the body. By using alternating current I found, as might be predicted, that the electrolytic action was too slight to interfere with the working. A number of experiments made later showed that it was possible to render practically *nil* the much stronger electrolytic action of direct current. To excite the active body and render it conducting, it is heated by an exterior source, and we have thus constructed a lamp which is always ready for use; on account of the incombustibility of the filament, a vacuum is unnecessary. The second arrangement is the combination of the incandescent filament and a supplementary heating body, which is traversed by the current and gives the heat necessary to raise the temperature of the filament; we have thus obtained an automatic lamp which lights up 10 or 20 seconds after the current is established. I have made lamps with fixed and movable heaters. One might suppose that after these explanations and the experiments shown that all difficulties had disappeared and the construction of the lamp might be commenced. I confess that a year ago I was of the same opinion, being ignorant of the obstacles to be overcome before being able to deliver to the public an apparatus which worked reasonably well in the laboratory."

The work of perfecting the lamp was carried out at the lamp factory of the Allgemeine Company by M. Bussmann,

superintendent, together with Doctors Ochs and Salomon. M. Bussmann makes some interesting observations as to work carried on there. "The refractory bodies used in the Nernst lamp have the advantage over the carbon employed in other luminous sources, in not being attacked by the oxygen of the air, so that a vacuum is not necessary. The numerous drawbacks due to the rarefaction of the air in the ordinary incandescent lamp are thus avoided. The light emitted by these refractory bodies approaches daylight in color; it has not, it is true, the warm yellow tones of the incandescent lamp, but on the other hand it is free from the violet tones of the arc lamp and the green of the Welsbach burner. Compared to the carbon filament, the new filaments have the disadvantage of being non-conductors of ordinary temperatures; they must be raised to 700 degrees centigrade to become conducting. In practice, this is done by a match, or if a globe is used, by an alcohol flame which is introduced through an opening. The lamps may be made in the ordinary forms of incandescent lamps; they are not expensive and the filament may be changed easily when worn out, keeping the base and the globe. Where it is not convenient to light the lamps, the automatic form may be used, in which the lighting is obtained by a current heating to whiteness a thin platinum wire rolled upon a porcelain tube, placed near the filament. An electro-magnet is placed in series with the filament, and when its field is formed by the current, it opens the circuit of the heater by attracting an armature. The mechanism, contained in the base of the lamp is quite simple and not likely to get out of order.

"The price of the automatic lamp is naturally higher than the other, owing to the electromagnet and the heater; the former is practically indestructible, the latter lasts a certain time, and afterwards, is taken back for two-thirds its original value. It is probable that the platinum wire will be replaced by a wire of a less expensive metal. Besides, the price of the changeable parts is quite low, so that the cost per hour is not more than that of an ordinary incandescent lamp. As to the life of the Nernst lamp, it may be averaged at 300 hours; the filament deteriorates by a molecular change which takes place little by little, this being accompanied by a diminution of solidity and often an increase of resistance which lessens its brightness. The expenditure of energy is from one and one-half to one and three-quarters watts per candle; the lamp is now made in 25, 50, and 100 candle-power for a voltage of 110 or 220. At present experiments are being made to produce a high candle-power lamp to replace arc lamps. As to the lamp-bottom for the automatic lamp, on account of the weight of the magnet, only the

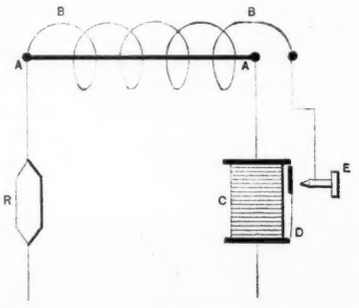


FIG. 2.—DIAGRAM OF CIRCUITS OF THE NERNST LAMP.

Edison and Swan types may be used, but for the ordinary lamp any lamp-bottom may be used. The Allgemeine Company will continue to manufacture incandescent lamps together with the Nernst

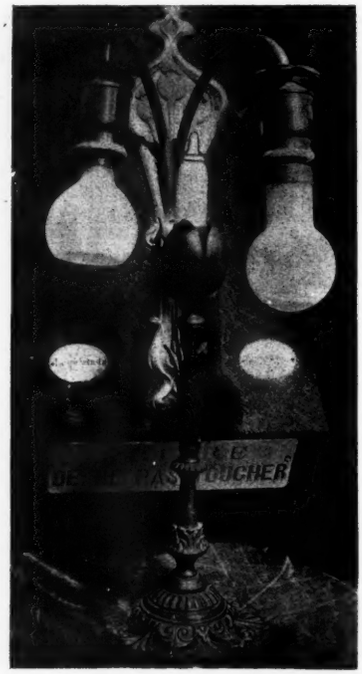


FIG. 3.—BRACKET AND PEDESTAL FIXTURES EQUIPPED WITH NERNST LAMPS.

lamps; it is not considered that the Nernst lamp will entirely replace the former, although it will not be without influence upon the consumption of incandescent and arc lamps. The new method of lighting will regain a part of the ground lost to the Welsbach burner."

The Allgemeine Company, which has a number of exhibits in different parts of the Exposition, has erected a pavillion of handsome construction, shown in the photograph, on the upper floor of the Electrical Palace, with a view of exhibiting the Nernst lamp and of showing the effect of the illumination obtained with it. To this end the pavillion is lighted in the interior exclusively by this lamp. The central room of the pavillion is richly decorated with frescoes under the dome and around the walls, the remainder being finished in white staff; some of the frescoes represent views in the different works of the company, and others are of an allegorical character. Around the dome are rows of lamps, and upon the walls are a number of very handsome lamp brackets in leaf design, each holding a dozen or more lamps; when the whole is lighted up a brilliant illumination is obtained. The light is much whiter than that of an incandescent lamp. A row of the latter, placed on one side, show the difference, these appearing quite yellow. The frescoes are brought out in almost natural colors, and the effect of the whole is pleasing.

Fig. 4 (page 279) gives a good idea of the present form of lamp, the globes being dismounted to show the working parts. On the left is the ordinary form which requires an external heating before it lights up; the automatic lamp, with its globe, is seen on the right. The ordinary lamp is quite simple in its construction. From the porcelain base rise two metal rods, joined at the top by a crosspiece in porcelain which serves as a brace. To the ends of the rods are soldered the wires which support the filament, this being quite short and of horseshoe form. Between the rods will be noticed a small glass bulb which contains the supplementary resistance. This is a fine iron wire placed in series with the filament; its resistance rises with the increase of current, and thus compensates for the decrease in resistance of the filament when incandescent. The wire is wound upon a porcelain tube and placed in the small glass tube as shown, being connected directly in series with the filament. To light this lamp it is only necessary to heat the filament with a match or an alcohol flame for a few seconds, when the filament is seen to redden at first, then becomes incandescent with a brilliant white light. The globe seen on the left is made with a metal base to fit in the socket, and it can be removed at will; it is open at the outer end. The automatic form of lamp is entirely self-acting; from the porcelain base,

which is hollow, rise three rods, passing through the lower porcelain disk and supporting an upper disk of the same substance. The ends of the rods pass through the upper disk and to these are fixed the horizontal filament and the heating spiral which surrounds it. This spiral is of porcelain which, before being baked, is surrounded with a great number of turns of fine platinum wire; this becomes imbedded in the porcelain during the baking and is thus firmly held, only the upper surface being visible. Upon passing the current the platinum wire heats up, and soon raises the temperature of the filament, which is placed in the interior, sufficiently to allow the passage of current in the latter. When the filament becomes incandescent the current increases sufficiently to operate a magnetic cutout which is placed in the base of the lamp, underneath the lower disk. The cutout breaks the circuit of the heating spiral, which is parallel with the filament. The arrangement of the circuits will be seen from Fig. 2, in which A is the filament and B the spiral; C is a small electromagnet with iron ends, placed in a hollow in the socket. To its lower part is attached a flat spring, carrying the armature D, which rests nominally against the stop E. At first the current passes in the filament and spiral, connected in parallel; when the filament has become heated and allows a sufficient current to pass in the magnet, the armature, D is attracted, thus breaking contact at E, for the circuit of the spiral which passes through it. When the lamp is extinguished, D falls back against E, re-establishing the former condition, R is the resistance, which is always in series.

FIG. 4.—DISMOUNTED NERNST LAMPS, EXHIBITED AT THE PARIS EXPOSITION.

The photograph, Fig. 3, shows a complete lamp of each of the two forms with their sockets, the automatic lamp is shown on the right; in this case frosted bulbs are used. The bulb of the automatic lamp is entirely closed, but a portion of clear glass is left at the end of the bulb. In the centre is an ornamental lamp of candle form, in which the candle is formed of a frosted glass cylinder supporting the filament at the end; in this form no protecting covering is used; the filament is of horseshoe form.

OBITUARY.

M. Bruno Abdank-Abakanowicz died recently of heart failure at his home near Paris, France. He was about forty-five years old and was well known in this country, which he had visited several times. He served as one of the United States jurors of awards at the Paris Exposition of 1889. He was a director in the original French Thomson-Houston Company, and had achieved considerable success in introducing American electrical apparatus in Europe. At the time of his death he was engaged in experimental work. He was a Pole by birth and spoke and wrote all the modern languages.

The death is announced, from apoplexy, of Mr. Frederick S. Kent, one of the oldest telegraphers in the West. His funeral services were held at Chicago on September 10. Mr. Kent was born in Boston and educated in the South. During the war he was a railway telegraph operator, and in 1865 went to Chicago where he secured a position with the Northwestern & Bloomington Railway. For thirteen years following this he was manager of the Western Union Telegraph office at Cairo, Ill. Afterward he became a newspaper man, in which profession he became well known. A widow, two sons and a daughter survive him.

The Erie Telephone system made a net gain of 2,972 subscribers in August. The total number connected on August 31 was 131,548. The number awaiting connection is 3,878.

AMERICAN STREET RAILWAY ASSOCIATION.

NEXT CONVENTION TO BE HELD IN KANSAS CITY, MO., OCTOBER 16-19.

The nineteenth convention of the American Street Railway Association, which will be held at Convention Hall, Kansas City, Mo., on Tuesday, Wednesday, Thursday and Friday, October 16, 17, 18 and 19, 1900, promises to be a most important meeting. The programme includes papers of a very practical character and of the sort likely to produce interesting discussions. An exhibition of street railway apparatus and supplies will be held, and October 19 has been set apart as a day to inspect these. The headquarters of the association will be at the Midland Hotel, where special rates have been secured. The annual banquet will be held at the Coates House, on Friday evening, when the new officers will be installed.

Plans for a special train from the East are being considered, and if it can be arranged, the train will leave New York early Sunday morning, arriving in Kansas City Monday night, thus spending but one night on the road. Quite a number of the street railway men from the eastern cities expect to attend. Announcements concerning the special train will soon be made by the committee having it in charge, which is composed of Messrs H. H. Vreeland, J. H. McGraw, T. C. Martin and Chas. W. Price, of New York city, and Chas. S. Clark, of Boston.

PERSONAL.

Rev. Frank W. Gunsaulus, D.D., has resigned the presidency of the Armour Institute, at Chicago.

Mr. W. B. McCurdy, of Chicago, who has been appointed New York manager for the American Electric Fuse Company, of Chicago, has opened offices at 116 Nassau street, New York city.

Dr. Louis E. Niles, of Springfield, Ohio, president of the National Magneto-Electric Telegraph Company, is visiting New York city. He is accompanied by Major R. B. Hoover, manager of the Central Union Telephone Company, at Springfield, Ohio, who is also connected with the National Magneto-Electric Telegraph Company. Major Hoover will be remembered by the electrical fraternity as the gentleman who proposed the testimonial to Professor Morse, which resulted in the handsome Morse statue in Central Park, New York city.

Automobiles

The Automobile Exposition, which will be held at the Greater Inter-State Fair, Trenton, N. J., on September 24, 25, 26, 27 and 28, promises to be a most interesting occasion. The management has issued a pamphlet giving the racing rules and describing the classes of vehicles which are eligible. The track is a half-mile track, 66 feet wide, and the races will be run under the racing rules of the Automobile Club of America. The entries close at noon on September 20.

The genuine automobile thief has at last made his appearance. Last Saturday evening, Dr. William Power, of Montclair, N. J., stopped in front of a residence in that town, and while he was paying his call somebody stole his automobile and rode away in it. The machine was found several miles away at an early hour the next morning, and from its appearance it was judged that the thief or thieves had tried to ride it over stone walls and through barbed wire fences. It was considerably damaged. This is believed to be the first case of the theft of an automobile yet recorded—in this country, at any rate.

Magistrate Olmsted, of the Jefferson Market Police Court, New York city, recently rendered a decision of interest to owners and users of automobiles. Mr. Stanley B. Atkinson was arrested while operating a steam automobile, and admitted that he had not taken out an engineer's license. The charge was entered against him of violating a section of the city charter which prescribes that only licensed engineers shall have the right to use and take charge of steam boilers carrying over 10 pounds of steam and of more than 10 horse-power. The bicycle policeman who made the arrest alleged in the complaint that the pressure carried on the steam boiler of the automobile was 220 pounds. Mr. Atkinson admitted the allegations in the complaint, but proved that the boiler of his vehicle was capable of developing only six and one-half horse-power. He therefore argued that the vehicle in question did not come within the provisions of the charter. The magistrate held that view to be correct and discharged the prisoner. If the decision holds good on appeal it will mean that no licenses will be required by owners and operators of steam automobiles, as very few of this kind of vehicle have 10 horse-power.

Automobilists are beginning to learn for themselves something new to them relative to pneumatic tires, says the New York *Sun*. According to repair shop men there is a large percentage of punctured tires being brought in on autos. In this respect the lot of the autofan is not a happy one. How natural it was for the automobile business to fall into the hands of the bicycle trade and how natural it will be for it to remain there is illustrated by the fact that a bicycle shop is the first place an autoist seeks when he has a punctured tire or when a part of the metal work breaks. The bicycle men have the tools and the "know how," and the carriage men have not. Autoists should, however, have some knowledge of what is required in repairing big pneumatic tires in order that they may not repeat the experience of a New York physician. A big nail punctured his tire and he paid $10 to have it fixed. The repair lasted only a few days, the plug blowing out because the fabric beneath the rubber was not sewed up. A puncture in one of the big tires almost invariably breaks the meshes of the fabric and this has to be caught up around the hole and treated to button-hole stitching in order to have a plug hold fast. Again, some repair men, of the hasty, careless kind, endeavor to vulcanize an automobile tire in the same way they do a small bicycle tire. This can not be done successfully. On the big tires the patch should be vulcanized with the plug or the job does not hold. Autoists knowing these things will seek for shops where they are almost certain of the work being done properly. Undoubtedly all the repair men along the roads will learn the tricks of the new game in time, but meanwhile mistakes are vastly more expensive and annoying than in the case of bicycle repairs.

A Direct-Coupled Steam Turbine.

A 1,340 horse-power Parsons steam turbine was recently tested at Elberfeld, Germany, by Herr W. H. Lindlay and Professors M. Schröter and H. F. Weber. The turbine is direct-coupled to a polyphase generator and runs at 1,500 revolutions per minute, says *Engineering News*.

FIG. 1.—CHANGING THE CABLE ROAD IN BROADWAY, NEW YORK CITY, TO AN UNDERGROUND ELECTRIC SYSTEM.

Using steam at 162 pounds pressure with 14.3 degrees Centigrade superheat, the following results were obtained:

Dynamo output Kw.	Lbs steam per Kw. hr.
1,190.1 (overload)	19.3
994.8 (full load)	20.1
745.3 (¾ load)	22.2
498.7 (½ load)	25.4
246.5 (¼ load)	33.8

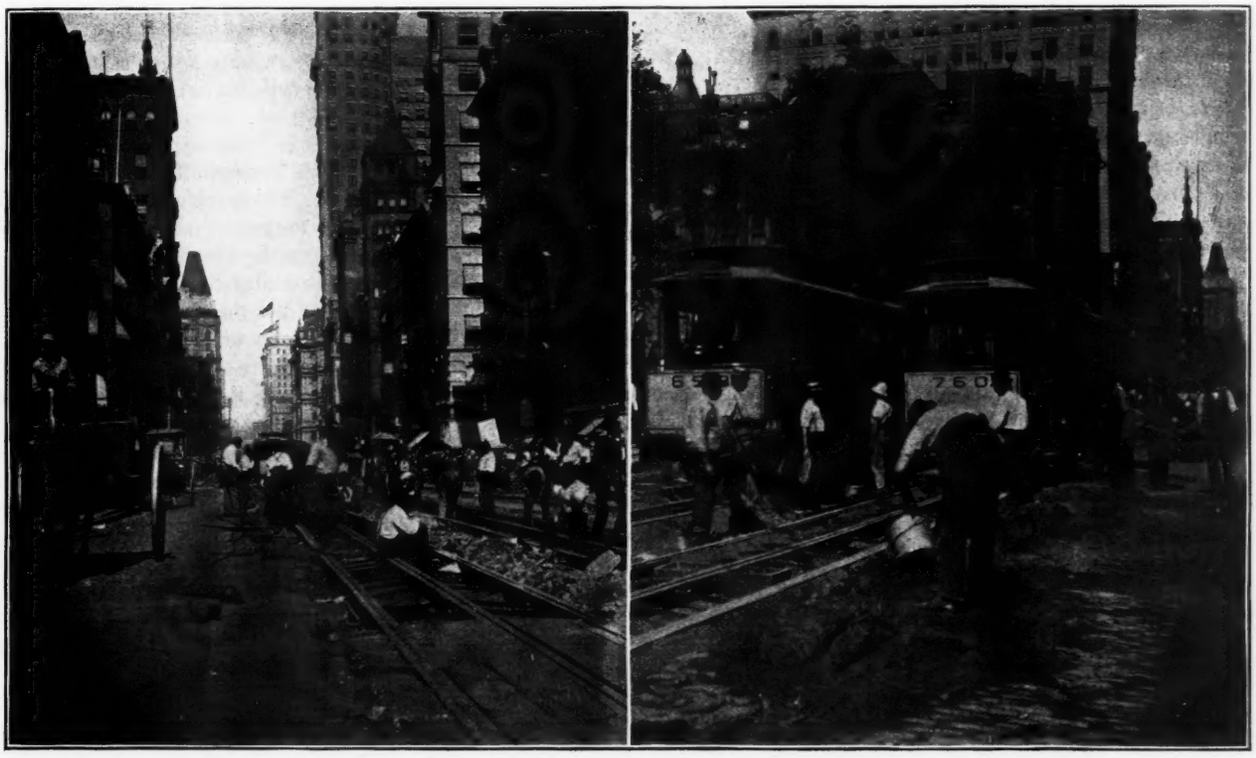
Running with no load but with the fields of the dynamo excited the consumption of steam was 4.057 pounds per hour, with the fields not excited the steam consumed was 2,604 pounds per hour. Twenty pounds of steam per kilowatt-hour is equivalent to about 15 pounds per electrical horse-power-hour. The condenser air-pump and dynamo exciter were driven from the shaft of the turbine. The speed regulation between no load and full load was 3.6 per cent.

Preparing to Operate the Broadway Cable Road by Electricity.

For several weeks past the Metropolitan Street Railway Company, of New York, has been engaged in making extensive alterations of the track equipment of its Broadway, Columbus avenue and Lexington avenue lines. These lines represent probably the busiest piece of street railway track in the world, and comprise among them the only existing cable system in New York city, and one of the very few that are left in the United States. As a preparation for the change to electric operation by the underground trolley or open-slot conduit system, the company has begun the relaying of the rails on this track and the placing in of the hand-hole boxes in which the insulators to carry the two steel conductors of the electric system will be placed. It is expected that the cable will remain in operation until some time early in the Spring of 1901, when the conductors will be installed in place and electric cars will supplant the grip cars on the busiest artery of the metropolis.

The new track that is being laid consists of 110-pound, seven-inch grooved girder rail. It is quite likely that if the track were being entirely rebuilt to-day a deeper section would be used, but at the time that the cable road was constructed, in 1892, a seven-inch girder rail was considered an extremely heavy section for street car service. This fact is mentioned as an illustration of the rapidity with which electric traction has developed and its extraordinary influence upon street railway engineering. Of course with the present yokes and foundations of the Broadway track it will not be possible to replace the rails with those of deeper section. The composition of the rails has been chosen with great care in order to secure the hardest steel that could commercially be manufactured and handled. The result is that the new rails contain between 0.55 and 0.65 per cent carbon and are calculated to withstand for a long time the exceedingly heavy traffic of street cars and wheeled vehicles on Broadway. The rails will not be bonded since no current is returned to them, but will be connected together with eight-bolt fishplates.

The illustrations herewith show the work of replacing the track in the busy district of lower Broadway. On this street, with the heaviest traffic of street cars and vehicles in the United States and only in the latter particular inferior to any other street in the world, the Metropolitan Company has changed the rails of its track and made all the preparations for electrifying the system without stopping traffic or street cars. This is an extraordinary achievement, but perhaps more astonishing is the great speed with which the work has been carried on, only three weeks having been necessary to complete the section from Fiftieth street to the Battery. The illustrations show better than any words can describe the manner of carrying on the work and the crowded nature of the thoroughfare in which it is done.



FIGS. 2 AND 3.—CHANGING THE CABLE ROAD IN BROADWAY, NEW YORK CITY, TO AN UNDERGROUND ELECTRIC SYSTEM, SHOWING CABLE CARS IN OPERATION DURING THE PROGRESS OF THE WORK.

The Mediterranean Railway Company, of Milan, Italy, has secured a concession from the Italian Government to substitute electric power on the line from Sampierdarena to Rome. A large power station is to be erected in the former town, and the company is about to purchase 23 electric locomotives. There is an inquiry from Milan in the hands of a New York electrical engineering firm for a complete electric light plant for an interior town in Italy, and according to information received from Milan the lack of direct representation in the mechanical and electrical engineering line in many parts of Italy is preventing direct business transactions between this and that country, while German, Belgian and British merchants are deriving considerable benefit from the importation of American-made apparatus and material.

Electric Railways

It is reported that the Grand Rapids, Mich., & Indiana Railway Company will build a line to Whitefish Lake.

The Stark County, Ohio, Commissioners have granted a franchise to the Stark Electric Railway Company for the construction of a line between Canton and Alliance *via* Louisville. Construction must begin by November 1 and $20,000 must be spent by next May or the franchise will be forfeited.

The Federal District Street Railway Company, which operates the street railway lines of the city of Mexico and Puebla, contemplate connecting the two cities with an electric road. There are a number of thriving towns in the vicinity of Mexico which will also be connected with the city by electric lines.

The change of motive power on the cable lines of the Little Consolidated Street Car Company, of Cleveland, Ohio, to electricity has necessitated the erection of an addition to the power house on Washington street. This building will be of brick and will cost $40,000. It is to be completed before the first of December.

Arrangements are being made to bring the business men of Neodesha, Cherryvale, Coffeyville, Parsons and Independence, Kas., together for the purpose of making arrangements for the construction of an electric line connecting these towns, which are the principal ones of the southern Kansas gas belt. This road has long been talked of and it can be built if these towns will do their share. The line will be about 75 miles long.

The project of building an electric trolley line from Auburn to Ithaca, N. Y., among the promoters of which are several prominent residents of the towns of Scipio and Venice, in Cayuga County, is, it is now said, likely to materialize at an early date. Information from Auburn says that the old road bed of the abandoned I. A. & W. Railway will be utilized a portion of the way, and that the road will pass through Fleming, Scipioville, Sherwood, Poplar Ridge, Ledyard, King Ferry, Goodyear's, Lake Ridge, Ludlowville, McKinney's and Renwick Park to Ithaca. The State Railway Commissioners recently gave their consent to the construction of a road over the old railroad bed from a point in the town of Lansing to Auburn.

Proposed Telephone and Telegraph Consolidation.

There have been numerous rumors of late concerning the probable amalgamation of all the telephone and telegraph companies of the United States. The ELECTRICAL REVIEW was recently informed that rapid progress was being made in this direction by the financial interests controlling the four leading companies. These are the American Telephone and Telegraph Company (which now includes the American Bell Telephone Company), the Telephone, Telegraph and Cable Company of America, the Western Union Telegraph Company and the Postal Telegraph Cable Company.

It is predicted by those in position to know that these interests will be consolidated into one big company to be known as the National Telephone and Telegraph Company, and that such consolidation will be accomplished before the end of the present century—which means before the end of the present year.

The American Telephone and Telegraph Company.

The amalgamation of the American Bell Telephone Company and the American Telephone and Telegraph Company (long-distance company) into the latter organization with headquarters in New York city, as was announced in the ELECTRICAL REVIEW at the time, was effected several months ago. The permanent officers of the company have not yet been announced. It is expected, however, that the new officers will consist of the board of directors that have so ably managed the affairs of the American Bell Telephone Company, and that the executive officers will be as follows: President, John E. Hudson; vice-president, C. J. French; general manager, E. J. Hall. The long-distance interests of the company are developing in many portions of its territory and the various Bell licensee companies are, in nearly every instance, enlarging and improving their plants.

An Automobile Run and Clambake.

The members of the Automobile Club of America, on Saturday, September 22, will have a run to the grounds of the Larchmont Yacht Club, Larchmont, N. Y., where they will be the guests of that club at its annual clambake. The run will start from Astor Court, New York city, at noon sharp, and the clambake will be served on the yacht club grounds at 2 P. M.

Telephone and Telegraph

The city council of Kansas City, Mo., passed the ordinance granting the franchise for a competing telephone system. The new concern, which will undertake to break the monopoly of the present Bell, Missouri & Kansas Telephone Company, is known as the Missouri Interstate Telephone Company. Rates will be cut about in two. Whereas now business telephones cost $96, they will be $48; residence telephone rates will be cut from $72 to $36. The new franchise has been secured after a bitter fight. The new company is to put up a $500,000 deposit at once as a guarantee of good faith.

A cable despatch from London states that M. Willot, chief inspector of the French telegraphs has communicated a paper to the Electricians' Congress, in which he states the conclusion that the earth and not the air or ether is the medium through which the signals of wave telegraphy are propagated. He conjectures that the disturbances received as signals leave the bottom of the vertical signalling wires and not the tops. The remainder of the cable despatch contains references to an alleged theory involving conducting strata in the earth which is not intelligible in the form in which it is printed in the newspapers.

The Illinois Telephone and Telegraph Company has filed amended articles with the county recorder of Cook County, Chicago, Ill. The new articles extend its corporate powers. Originally they were merely "to acquire, construct, build, buy, sell, lease and operate plants for the conveyance of sounds and signals by electricity." Under the amended articles power is given "to distribute, convey and deliver telephone messages, telegraph messages, packages, mails, newspapers and general merchandise, and to convey, distribute, deliver and furnish power, heat and light by steam, water, air, electricity or otherwise, but not by railroad." President Wheeler says work on the big subways under the down-town district is progressing rapidly. An automatic telephone switchboard has been installed in the offices in the Rookery Building.

An electric tramway is to be run between Grangeville and Buffalo Hump, Idaho, a distance of 50 miles, inside of eight months.

THE STORM AT GALVESTON, TEXAS.

DETAILS OF ELECTRICAL INTEREST.

The civilized world is by this time thoroughly familiar with the appalling results of the fearful storm which wrecked the city of Galveston, Tex., on September 8. While the catastrophe is one of the most awful in the history of the world, the chief interest now centres in the relief of the survivors, the care of the injured and the reconstruction of the city. The Governor of Texas now has in his hands nearly $2,000,000 subscribed as a relief fund from all parts of the world. The prominent newspapers of the country have sent relief trains fully equipped with nurses, physicians and supplies and these are accomplishing great results. In the meantime the details of the awful catastrophe are gradually being brought to light.

The features of the storm of especial interest to the electrical fraternity are described as follows: The city gas and electric light plants are totally wrecked and the city has been in practical darkness since the hurricane. The city is under martial law and all stores except drug stores close at dark. The streets are so filled with debris that people who are obliged to be out at night are compelled to carry lanterns and unless one has a pass he is arrested.

The Mexican Cable Company lost its cable by the storm and the cable hut near the beach was completely washed away. As soon as the storm subsided a large force was engaged and the hut was rebuilt. After much difficulty the cable was recovered and connection was made last Sunday night.

On last Saturday the Western Union had two wires working "quad" to Galveston and expected to have two more working that night. The information of the ELECTRICAL REVIEW is that the company is doing everything to restore its facilities destroyed by the storm, but this work is simply temporary in order to restore and maintain communication. It will probably be some time before a fair estimate can be made of the real result of the disaster and the time necessary to reestablish telegraph facilities that were literally wiped out. The immense volume of traffic is being handled by wire, messengers and boats with remarkable promptness considering the totally inadequate facilities at the company's command.

The ELECTRICAL REVIEW is informed that telegraphic communication with Galveston was restored over the Postal Telegraph Cable Company's wires on Friday, September 14. Additional facilities were expected to be in working order within a few hours.

On account of the great pressure of business, telegrams will naturally be subject to considerable delay. Since communication was established by a despatch boat with Houston, between 12,000 and 15,000 telegrams have been handled, beside an immense amount of press and special reports to the papers throughout the United States. The temporary telegraph offices in Galveston are crowded with people anxious to inform their friends in other parts of the country or send news of deaths.

The "Electrical Review" Receives a Paris Award.

TO THE EDITOR OF ELECTRICAL REVIEW:

UNITED STATES COMMISSION
TO THE
PARIS EXPOSITION OF 1900.
PARIS, August 31, 1900.

I have the honor to inform you that in accordance with the official announcement of awards at the Paris Exposition of 1900, a grand prize was bestowed upon the exhibit of United States journals, publications and periodicals, and that you are therefore entitled to use this award of grand prize.

Respectfully yours,
A. S. CAPEHART,
Director of Liberal Arts
and Chemical Industries.

Wire Manufacturers Form a Coalition.

The Washburn Wire Company has acquired an interest in the plant of the American Electrical Works, located in East Providence, R. I., makers of bare and insulated copper wire, and will not build a copper wire plant as has been reported. The management of the Washburn Wire Company has been very reluctant to bring any additional wire machinery into operation, and has secured a location for its works immediately adjoining the plant of the American Electrical Works, in order that this purpose might be accomplished.

Street Railway Association of the State of New York.

The annual meeting of the Street Railway Association of the State of New York is being held this week at Buffalo, N. Y. The convention dates are September 18 and 19 and the headquarters are at the Hotel Iroquois. An interesting programme of papers has been provided and the entertainment features are instructive as well as enjoyable.

THE CHICAGO AUTOMOBILE EXHIBITION AND RACE MEET.

DETAILS OF THE SHOW HELD UNDER THE AUSPICES OF THE "INTER-OCEAN."

[SPECIAL DISPATCH TO THE ELECTRICAL REVIEW.]

CHICAGO, September 18—The International Automobile Exhibit and Race Meet, under the auspices of the Chicago *Inter-Ocean,* opened this morning at Washington Park with great *eclat.* All the leading manufacturers of electric, steam and gasoline vehicles have on exhibition the various types manufactured. Makers of batteries, rubber tires and all other accessories are also exhibiting. An unusual amount of interest is manifested. The display is very attractive, and the expected attendance for the week will be large. Thirty or more booths, containing the exhibits, are all prettily decorated. Many outside visitors and prospective buyers are present. A very interesting programme of races has been arranged for each day. It is expected that many records will be broken in the competitive races. The electromobiles, as entered, command much attention. The foreign racing machines also form an interesting feature.

All short-distance automobile speed records were broken by T. E. Griffin, who sent his vehicle a mile in 1.06. Griffin says that he will make the distance tomorrow in 1.02 and probably in one minute.

The management has spared no means to make the show a great success. The weather is fair and a hard track will help to make records.

Nearly all the available exhibition space is taken, and the manufacturers interviewed think great benefit will be derived from the exposition. All precautions have been taken against accidents, and every means known has been utilized to educate the public to the preference, convenience and use of automobiles.

The Chicago Automobile Club has its headquarters at the Victoria Hotel. Tests for friction, economy of power, speed, safety devices, mechanical construction, noiselessness, etc., will be judged by a committee of men high in the mechanical and engineering world. Everything points to a successful exhibition, benefiting the industry in the west greatly. F. E. C.

The contact for the power house and all of the buildings to be erected on the grounds of the Sayville, N. Y., Electric Light and Power Company has been awarded to William Bason & Sons, of that place.

ELECTROMAGNETIC MECHANISMS.*

BY SILVANUS P. THOMPSON.

In all the mechanical applications of electric currents there intervene electromagnetic mechanisms whose principles are more or less understood. The first of these principles is the law of the magnetic circuit. Suspected by Joule 60 years ago, formulated by Rowland 16 years ago, it was at last brought into full light in 1886 by Kapp and the Hopkinson brothers. In its application to the construction of dynamo machines this law has received the most striking practical confirmations. From that time the calculation of these machines has become a part of the exact sciences.

In the second place comes the law of induction of electro-motive forces by the relative movement of magnets and electric circuits, discovered by Faraday in 1831. From this law may be deduced the quantity of electric energy absorbed in an electromagnetic mechanism in its movement, by integrating, relative to the time elapsed, the product of the current and electro-motive force of the reaction.

To these laws we may add a third, still more general, which dominates all electromagnetic mechanisms of whatever kind. All these mechanisms may be regarded as constituted by separate parts assembled in a movable system. There will always be found coils or conductors whose function is to conduct the electric current, and cores or masses of iron or other magnetic material, unless these are replaced by a second system of coils equally traversed by a current (the case of so-called electrodynamic phenomena, discovered by Ampère). In every case these organs will be found assembled, in a certain configuration, in a surrounding medium, either in air or a medium of magnetic permeability much lower than iron. Let us consider the most general case where the arrangement of the parts, simple or complex, is in any possible way. We may then admit the following law: In any electromagnetic system, of any configuration, traversed by an electric current, there are always mechanical forces which tend to change that configuration in a sense such that the flux of magnetic force will be made a maximum.

This principle may be enunciated in several forms, for instance the following: In every electromagnetic system there is always a tendency to act in such manner that the *reluctance* (or magnetic resistance) shall be made a minimum. In every electromagnetic system the different parts tend to change their disposition in such manner that the magnetizing coils embrace as many lines of magnetic force as possible. Or, again, in every such system there exist forces such that the movement they produce increases the product of the current by the flux with which it is interlaced. Let I be the current in a conductor. If by a change of the configuration of the system the flux of force surrounded by the circuit increases from Ψ_0 to Ψ_1, the work produced will have evidently the value of $I(\Psi_1 - \Psi_0)$; or, if S is the number of turns, the work will be $IS(\Psi_1 - \Psi_0)$. This work, effected by a corresponding expenditure of electric energy, tends always towards a maximum. If, in the movement where this energy is expended, the relative displacement of the organs is of length l, the mean force f exercised between the organs will be given by the equation

$$f = \frac{IS}{l}(\Psi_1 - \Psi_0).$$

Or, more generally, when a displacement δx produces an increase $\delta\Psi$ of the magnetic flux, the force which tends to produce this displacement, will have a value, per turn of the circuit, of

$$f = I\frac{\delta\Psi}{\delta x}.$$

All the forms, extremely varied, of electromagnetic mechanisms, are controlled by this fundamental principle. An electromagnet tends always to act as if it sought to shorten the length of its magnetic circuit. Let us consider an electromagnet in horseshoe form, its two cores surrounded each by an exciting coil, its armature, in iron, separated from the poles by a suitable air-gap. When the current is passed, the masses of iron attract each other mutually. If one or the other is movable a movement is produced, and the width of the air-gap is reduced. By this reduction there is a reduction, almost proportional, of the reluctance or magnetic resistance, and a corresponding increase of the flux of magnetic force. The magnetic circuit tends in every case to shorten itself.

It is the inverse of that which occurs for the circuit of an electric current. The latter has always a tendency to extend itself so as to embrace as much space as possible, while the magnetic circuit tends always to become as compact as possible. The two phenomena are derived from the same principle, because the electric circuit, in enlarging, causes the section of the magnetic circuit to increase in the surrounding medium, and, in consequence, the flux of force.

We know that in all physical systems the principles of energy dominate mechanical actions, and that in all of them there is a tendency towards the increase of the entropy, that the potential energy of a system tends always towards a minimum value. This tendency of masses of iron, in an electromagnetic system, to move so as to become as strongly magnetized as possible, shows us that a mass of magnetized iron possesses less potential energy than the same mass not magnetized. It results from this that the specific heat of magnetization should have a negative value.

Let us return to the principle that the work effected by a change in the configuration of an electromagnetic system may be represented by the expression $IS(\Psi_1 - \Psi_0)$. Let us apply it to the case of the apparatus which we designate by abbreviation by the name of *coil and plunger;* that is, of the system in which an iron core is attracted into the interior of a tubular coil or *solenoid.* Here again the fundamental principle formulated above suffices as guide. The system is submitted to forces which are exercised between its parts, the coil and the plunger, which tend always to change its configuration so that the flux embraced by the turns carrying the current becomes as great as possible. The position of stable equilibrium of the plunger, towards which it tends always to come, is the position symmetrical with relation to the coil, making an equal projection on one side and the other (if it is cylindrical) by its extremities, this position being that for which the magnetic circuit is the best completed. The forces exerted in each position of the plunger may be obtained by considerations similar to those exposed above. A paradoxical case presents itself when the length of the plunger is reduced to a minimum; that is, presented, when, in place of a cylindrical core, a small iron ball is used to explore the interior of the solenoid.

The curious result is obtained that the only point where any effort is exerted upon the ball is just that where it enters or leaves the opening of the coil, at the interior, except for some decrease near the extremities, the magnetic field, strong or weak, is nearly uniform; and in a uniform field a ball of iron undergoes no action. At the exterior, except in the immediate neighborhood of the opening, there is no magnetic field, and the ball is not attracted. It is at the entrance of the tube itself that the relation $\frac{\delta\Psi}{\delta x}$ has its maximum value. A very small displacement may determine whether the ball will be strongly magnetized or whether scarcely at all. It tends always to move towards the position where it is the most strongly magnetized; and it is always submitted to forces whose value in each point depends upon the increase of its magnetization when it is displaced by an infinitely small quantity.

It would be easy to multiply the examples of electromagnetic systems, and to demonstrate that in all of them it is the same principle which governs their actions. Even in the case of electric motors it is the same. In the rotating coils of motors we find that the turns conducting the current are successively submitted to motive forces which displace them in a sense such that if the working of the commutator did not intervene, at a given instant, to change the direction of these currents, the flux of magnetic force embraced by the turn would take a maximum value.

In my treatise on the electro-magnet, which appeared in England in 1887, I sketched an exposition of the principles of the magnetic circuit and of its applications to the phenomena and the con-

*A paper read before the International Electrical Congress, Paris, August 21, 1900.

struction of electromagnets and I have devoted a chapter to the subject of electromagnetic mechanism. I have added a simple enumeration, by categories, of the numerous forms of electromagnetic mechanisms known, remarking that the time has not yet come for being able to group into a logical and synthetic system—into a veritable *electrokinematics*—all the varieties of these mechanisms. In this communication upon the present state of this branch of electrotechnichs, I propose to reproduce this classification, imperfect though it may be, somewhat reviewed and enlarged.

The writer divides electromagnetic mechanisms into 17 general classes, and gives example of the different forms in each class. In the present instance, only the principal classes will be given:

I. *Electromagnets.*
   A. Coil and core fixed; armature movable.
   B. Coil and armature fixed; coil movable.
   C. Armature and coil fixed; core movable.
II. *Coils with Plunger.*
   A. Solenoid fixed and plunger movable.
   B. Plunger fixed and solenoid movable.
III. Forms intermediate between the preceding.
IV. Coil fixed and coil movable.
V. Electromagnets combined with reacting apparatus (weights, springs, etc.).
VI. Equalizers for electro-magnets.
VII. Electromagnetic cams.
VIII. Electromagnetic chains.
IX. Escapements.
X. Relays, etc.
XI. Apparatus based upon the repulsion of electromagnets.
XII. Dispositions of polarized electromagnets.
XIII. Vibrators—*a* Non-polarized, *b* Polarized.
XIV. Rotative electromagnetic dispositions.
XV. Electromagnetic adherence.
XVI. Magnetic brakes.
XVII. Dispositions with alternating currents.

The dispositions using alternating currents given in No. XVII do not form an exception to the general law which governs all electromagnetic mechanisms, however different appear their method of working. A disk or ring of copper is repelled by the pole of an alternating magnet, because the Foucault currents induced in its mass, being inverse currents (somewhat displaced in phase), tend to diminish the flux of force in the magnetic circuit. According to the fundamental law which recognizes a tendency to make this flux increase to a maximum value, mechanical forces should be found acting between the different parts of the system, such as tend to drive away the inverse currents. In fact, there is a repulsion between the core and the ring, and also between the latter and the exciting coil. In every case the general law holds good.

THE ZEEMAN EFFECT.*

BY HERBERT M. REESE.

Early in the year 1897 a paper was published in several journals by Dr. P. Zeeman, describing a series of experiments to determine the effect of magnetism upon the spectrum of a source of light placed in the magnetic field. The electromagnetic theory of light indicated in a general way that there would probably be some effect, and several investigators had already sought for it without success. The most noteworthy of these was Faraday, who made it the object of one of his last researches, and in this country Rowland made an examination with a Rutherford grating, before he had himself begun to rule the more perfect gratings of the present day. Zeeman himself had made an earlier unsuccessful attempt, and Fievez really observed what may have been the same phenomenon which Zeeman finally discovered, but he failed to understand its true character.

With the aid of a strong magnet and better spectroscopic apparatus than any of his predecessors had used, Zeeman attacked the problem the second time with success. He placed a Bunsen flame containing common salt between the poles of the electromagnet and focused the light on the slit of his spectrometer, arranging the flame so that the D-lines were sharply defined. As soon as the magnet was excited both lines widened out very much. By a careful series of subsidiary experiments he showed that the widening was due directly to the action of the field and was not a secondary effect such as might be caused by changes of density in the flame.

These results were communicated before publication to Professor Lorentz, who showed Dr. Zeeman that the widening could be predicted from Lorentz's theory that light is generated by the vibrations of electrically charged particles or ions; and that the same theory indicated that the edges of the widened lines should be plane polarized or circularly polarized according as the light falling upon the slit came from the source in a direction perpendicular or parallel to the lines of magnetic force, and that the amount of the widening would give the ratio of the charge to the mass of the luminous particles. Zeeman was able to verify fully the predictions as to polarization, and deduced from Lorentz's equations, as a rough value for the ratio e/m, the value 10^7.

The substance of the reasoning which led Lorentz to his conclusions is this: the motion of any ion can be resolved into a rectilinear component along the lines of force and two circular components in opposite senses in a plane normal to the same lines. These moving charges constitute currents, and consequently there are electromagnetic forces acting on the particles carrying the charges, owing to the presence of the magnetic field. The component along the lines of force is unaffected, while one of the circular components is accelerated and the other retarded by an equal amount. Hence we have present three distinct vibrations: One linear, along the lines of force, with the same period as the undisturbed motion; and two circular, in opposite senses, having periods, one a little longer and the other a little shorter than the original. Hence if the difference of periods introduced is sufficient to resolve the three lines in the spectrometer, and the light falling upon the slit comes from the source in a direction parallel to the lines of force, two lines instead of one will appear in the spectrum, one composed of right-handed and the other of left-handed polarized light; for the linear vibration can send no wave in its own direction. On the other hand, if the light proceeds directly across the lines of force to the slit, a triplet will be seen, consisting of a central component polarized in a plane normal to the lines of force and two lateral components polarized in a plane through the lines of force (bearing in mind that on the electromagnetic theory of light the direction of electric force is normal to the plane of polarization). But if the difference of period is smaller the lines of the doublet in the one case and of the triplet in the other, being streaks of finite width and not lines in the mathematical sense, will overlap, forming a single widened line whose edges alone show any definite polarization. Lorentz's mathematical treatment, which we will omit here, leads to the expression

$$\frac{\Delta\lambda}{\lambda^2} = \frac{e}{m} \cdot \frac{H}{2\pi V},$$

where λ is the wave length of the original line, $\Delta\lambda$ is the difference in wave length introduced between the extreme components of the triplet by the external magnetic force H, e is the charge on the moving ion, m its mass, and V the velocity of light.

It follows from this that if e/m is the same for all the luminous ions which give the spectrum of any one substance, the separation $\Delta\lambda$ is proportional to the square of the wave length; but it became evident as soon as the experimental study was extended that no such general law could be laid down. For the same region in the spectrum of an element the separation may vary from apparently nothing up to an Angström unit or more for a moderately intense field.

The high value of e/m indicated by this phenomenon is significant. It is of about the same order as that found for the cathode ray particles and the ions caused by uranium and Roentgen rays and ultraviolet light; but the value for electrolytic ions is only about 400.

Zeeman's experiments were soon repeated by other investigators, including Lodge, Michelson, Preston and Cornu; and it was not long before magnetic fields were used of strength sufficient to fully resolve the several components. It then became known that the phenomenon was not near-

*From *Science*.

ly so simple as the first observations would indicate. Lodge* first noticed indications of a quadruplet in the case of the *D*-lines instead of a triplet and later Preston† and Cornu‡ observed unmistakable quadruplets both in the case of D_1 and in the spectra of cadmium and magnesium. A little later Becquerel and Deslandres§ discovered in the iron spectrum a new type of triplets in which the states of polarization of the inner and outer components were interchanged. In February, 1898, Michelson published in the *Astrophysical Journal* a paper giving results obtained with the interferometer, some of which are not in accord with those obtained before and since then with the grating. Among other things he said that all lines are divided into what may provisionally be called triplets of approximately the same width, each member of a so-called "triplet," however, being itself complex, making the whole magnetic group formed from a single natural line quite complicated. As has already been stated, other investigators have found the degree of separation to vary quite strikingly even for neighboring lines, and although researches with the grating have discovered many complicated lines, the number of these is very small compared to those that appear as simple triplets. Professor Michelson maintains in defense of his methods that the resolving power of a grating is not sufficient to reveal the finer structure of the line as indicated by the interferometer. This last is no doubt true, but on the other hand the interferometer method is exceedingly indirect, and one hesitates before accepting conclusions drawn from an estimated visibility curve as to the distribution of intensity in such a complicated source as he advocates. In any case, the assumption is involved that the source is symmetrical, and this certainly is not always true. An example is found in the cadmium group 4,678, 4,800, 5,086, and the similar group in the spectrum of zinc. Each of these lines in the spark spectrum shows a decided shading on the red side, which is retained by each component when they are separated by the magnetic field, making the whole group quite asymmetrical. It has also been shown** that many triplets and quadruplets are asymmetrical in separation. It is quite possible that such cases may account for some of Professor Michelson's results.

It can not be denied, however, that, although most lines become simple triplets in the field, many are more complicated than the simple theory would indicate, many being fourfold and some at least sixfold, while some seem not to be effected by the field. Several theories have been devised to account for these variations, which will be discussed later.

Some attempts to classify the spectral lines according to the character and extent of their magnetic separation have met with partial success. Preston* found that in the spectra of magnesium, cadmium and zinc, corresponding lines of the homologous groups of three at the head of Kayser and Runge's second subordinate series act in exactly the same way in the magnetic field. That is, the most refrangible line in each group becomes a sharp triplet with the value 10 (relatively speaking) for the ratio $\lambda^2/\triangle\lambda$, the middle line a sextuplet with the value 11.5, and the least refrangible a rather diffuse triplet with the value 18.

A magnetic effect has been noticed on some of the air lines,† but, with the possible exception of nitrogen peroxide, no effect has been observed on band spectra, either by emission or absorption methods.

On the continent of Europe most of the work has been done with absorption spectra, particularly with that of the sodium flame; and in this field several most important discoveries have been made.

Egoroff and Géorgiewsky‡ noticed that the light from a sodium flame in a magnetic field is partially polarized as a whole, *i. e.*, without being dispersed. Lorentz§ showed that this phenomenon can be explained by absorption even when the field is uniform.

Righi‖ and Cotton¶ have shown how the Zeeman effect may be demonstrated without a spectroscope by passing a plane polarized beam of white light through a magnetized sodium flame or absorbing gas. By this method, which is very sensitive, nitrogen peroxide was shown to be subject to magnetic separation.

Macaluso and Corbino* discovered that a magnetized sodium plane rotates the plane of polarization to a very great extent for light whose wave length is nearly that of one of the *D*-lines. Very close to the absorption lines the rotation amounts to as much as 315 degrees. The immediate dependence of this phenomenon upon the Zeeman effect is shown in a very beautiful way in Cotton's little book "Le Phénomene de Zeeman," although I believe the more general principle that magnetic rotation of the plane of polarization is dependent upon the optical dispersion of the medium combined with a sort of generalized Zeeman effect, is due to Fitzgerald.†

An analogous effect of the magnetized flame upon light passed through it across the lines of force was discovered independently by Voigt‡ and Cotton§. They found that the flame acts like a uniaxial crystal; that is; it introduces a phase difference between waves polarized parallel and perpendicular to the lines of force. This phase difference increases very rapidly as the wave length approaches that of one of the *D*-lines. The explanation of this is also given in Cotton's book.

When we review the experimental facts concerning the effect of magnetism upon light we find many things inconsistent with the elementary theory first given by Lorentz. The equation which he obtained indicated that all spectral lines should become triplets under the influence of the field, and that the separation should vary as the square of the wave length and as the strength of the field. On the contrary, we find a considerable number of lines which become more complicated than triplets as well as some that are apparently unaffected; moreover, the separation is very far from varying as the square of the wave length, and recent work has shown that in some cases, at least, it is not proportional to the strength of the field.* In spite of these inconsistencies, however, we do not feel called upon to abandon the theory of electrified ions, for we must bear in mind that Lorentz's expression was deduced from assumptions which can hardly be realized in nature. He assumed a molecule of the simplest possible kind, consisting of a single positive or a negative ion acted upon by a central force proportional to its displacement and an electromagnetic force due to the external field equal in magnitude and direction to that which would act on a conductor carrying a current equal to the product of the velocity of the ion by the charge which it carries. Now it seems reasonable to suppose that the central force varies directly as the first power of the displacement because if it varied as any other power the period of vibration would change with the amplitude, and the spectral lines would change their position when the source of light became brighter, which has never been observed. The assumption that the same forces act on a particle carrying a charge e with a velocity v as would act on a conductor carrying a current of strength ev in the same direction is justified for comparatively low velocities by Rowland's experiment in Berlin in 1876. It seems utterly impossible, however, that a molecule should consist of a single ion, for in very few cases does the spectrum of an element contain less than 20 lines in the visible spectrum, and in the iron spectrum there are thousands of them. A molecule which can vibrate in so many different periods must be exceedingly complicated. It is not surprising, then, that our simple theory is inadequate to account for the facts. Lorentz, in fact, knew this and instituted** a theoretical research on more general grounds before its insufficiency had been shown by the discovery of the quadruplet and other complications. He found that if the molecule naturally possessed more than three equivalent modes of vibration—that is, if it could vibrate in more than three ways with the same period—then the single spectral line

The Electrician, June 18, 1897.

†*Proc. Roy. Soc.*, Vol. 63, p. 26.

‡*Comptes Rendus*, Vol. 126, p. 181.

§*Comptes Rendus*, April 4, 1898, p. 997.

**Zeeman, *Proc. Roy. Amst. Acad. Sci.*, Dec. 30, 1899. Reese, J. H. U. Circulars, June, 1899; June, 1900.

*Phil. Mag., Vol. 47, p. 165.

†Becquerel and Deslandres, *Comptes Rendus*, Vol. 127, p. 18.

‡*Comptes Rendus*, Vol. 124, pp. 748, 949.

§*Proc. Roy. Amst. Acad. Sci.*, Vol. 6, p. 198.

‖*Comptes Rendus*, Vol. 127, p. 216.

¶*Comptes Rendus*, Vol. 125, p. 865.

*Comptes Rendus, Vol. 127, p. 548.

†*Proc. Roy. Soc.*, Vol. 63, p. 31.

‡*Wied. Annal.* No. 2, 1899, p. 345.

§*Comptes Rendus*, Vol. 128, p. 294.

*Shedd, *Phys. Rev.*, July, 1899, p. 1; Aug., 1899, p. 86. Reese, J. H. U. Circulars, June, 1900.

**Wied. Annal., Vol. 63, p. 278. *Astroph. Jour.*, Vol. 9, p. 37.

corresponding to this period would become more than threefold under the influence of magnetic force. Professor Lorentz does not regard this explanation as satisfactory, owing to the difficulty in conceiving a system having this property.

More recently Voigt† has proposed a theory which accounts for all the observed phenomena and is especially interesting in that by it he predicted cases of asymmetry found by Zeeman and others. Unfortunately, the theory does not give any mechanical conception of the subject, merely consisting of the introduction into the equations of motion of terms of arbitrary form, which have no apparent justification.

It is comparatively easy to treat the case of a molecule composed of two ions carrying equal charges of opposite signs, and, in fact, Professor Rowland has lately given such a treatment before his students at Johns Hopkins University, but it leads to no new results as regards the Zeeman effect. Any case more general than this is very difficult.

A Simple Closed-Conduit Traction System.

The illustrations herewith represent some details of a novel and interesting system of electric traction making use of a sectional conductor connected appropriately to a feeder as the car passes over it. Fig. 1 shows the working conductor and one of the contact-making devices in section.

Installed between the two rails of the track is a sectional rail which may be of any convenient shape, but preferably one similar to that shown in the illustration, since this presents a small surface in the street and can easily be worked in with the pavement. This rail is divided into sections longitudinally, the length of each section being about one-quarter that of the cars which are intended to run over it—on ordinary tracks, say about 12 feet. This rail is laid on a continuous stringer of wood or concrete in which, at intervals of about four feet, are placed the contact-making receptacles well illustrated in Fig. 1. These consist of a porcelain shell containing an aluminum cup. The cup is partly filled with mercury and in this is immersed the stem of the rivet-shaped contact-making device which is adapted to be attracted upward against the under surface of the working conductor when the latter is magnetized. Attached to the car is a pair of electromagnets, shown in Fig. 2, hinged to which (solely for convenience) are the current-taking devices shown in the same figure. These magnets are energized by a storage battery of small size carried on the car and adapted to be recharged by connection to the lamp circuit of the car. Its energy consumption is, of course, very small and may be made as little as 50 to 100 watts. As this device sweeps along over the iron or steel sectional rail it produces in the latter magnetic poles which attract the rivet-shaped contact-making pieces described above. Interposed between the head of each of these and the lower surface of the rail is a copper or brass washer so that any slight residual magnetism in the rail itself will not cause the contact maker to stick to it and fail to fall back. The operation of

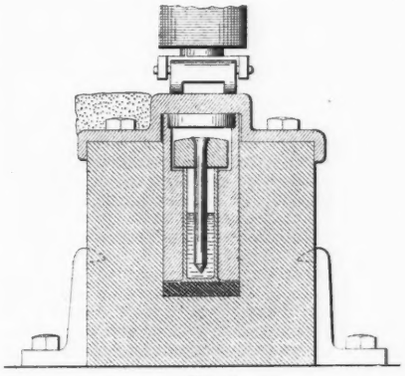


Fig. 1

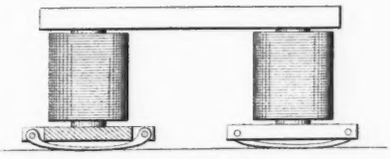


Fig. 2

A Simple Closed-Conduit Traction System.

the system is easily to be understood from the above. As the car runs along the contact makers come up under it, energizing in succession the various sections of the sectional conductor and thus supplying current to operate the car. As the contact maker can not fall while current is on it or unless it is shunted with another similar device it is practically impossible to have sparks in the switch devices. It is intended that a strap conductor shall be run along in the groove under the various switches, as shown in the illustration, and from this the current fed directly, though this construction is not essential.

The system, which is the invention of Mr. Lowell M. Maxham, is operated by the Bay State Traction Company, with offices in New York and Boston.

†*Wied. Annalen*, No. 2, 1899, p. 345; No. 6, 1899, p. 352; No. 9, 1899, p. 290; No. 2, 1900, p. 376 and p. 389.

Electro-Synthesis.

The following is an abstract of a paper by Mr. O. Dony-Hénault which appeared in the *Zeitschrift fuer Elektrochemie,* and i *Science Abstracts* for August: "In the electro-synthesis of organic compounds two classes of reactions are to be distinguished—those in which the compound is formed by the inter-action of the ions, as in the formation of ethane by the electrolysis of acetic acid, and those in which the liberated ions act on a non-electrolyte in the vicinity of one of the electrodes, as in the reduction of nitrobenzine to aniline. This paper is the first of a series in which it is proposed to study reactions of the second class more systematically than has hitherto been done. Stress is laid on the importance of ascertaining the exact experimental conditions favorable to each synthesis, and the electro-motive force at the working electrode is considered to be of more value than the current density as a measure of the chemical action of the ions. Every organic compound capable of entering into reaction with the liberated ions acts as a depolarizer, and the requisite condition for the decrease of potential is that the reaction shall take place with loss of free energy. Thus the electrolytic decomposition point for chlorine ions in normal hydrochloric acid is 1.31 volts (compared with hydrogen), whilst in the presence of phenol the required electromotive force is reduced to 0.9 volt. Accordingly, as some preliminary experiments have already indicated, the quantitative conversion of phenol into one or more chlorine derivatives should be made possible by careful regulation of the electro-motive force. Similar observations apply to the preparation of bromine derivatives of phenol. A series of experiments, described in detail in the paper, has been carried out on the electrolysis of dilute sulphuric acid in the presence of methyl and ethyl alcohols. The results show that by keeping the anode potential between 1.3 and 1.66 volts throughout the electrolysis a quantitative conversion of ethyl alcohol into aldehyde is effected; with higher potentials the yield of aldehyde diminishes, and acetic acid and ethyl hydrogen sulphate are formed. In the case of methyl alcohol the author confirms Renard's observation that formaldehyde is not produced, the primary oxidation product being probably methylal. The paper concludes with some remarks on the analogy between chemical and electrochemical modes of oxidation, and it is shown that the limited oxidation of alcohol to aldehyde can be effected chemically by means of cupric oxide or lead peroxide in alkaline solution."

THE TESLA PATENTS.

SWEEPING DECISION IN FAVOR OF THESE PATENTS BY THE UNITED STATES CIRCUIT COURT.

Judge Townsend of the United States Circuit Court of Connecticut, recently handed down the decision sustaining the three Tesla patents of May 1, 1888. These patents are numbered 381,968, 382,280 and 382,279. The suit was that of the Westinghouse Electric and Manufacturing Company against the New England Granite Company.

The decision is a very sweeping and interesting one to the entire electrical fraternity, and we present it almost in full herewith.

TOWNSEND, District Judge.

The patents in suit relate to the art of electrical transmission of power by the use of mechanically generated alternating electric currents.

It is, of course, understood that the real nature of electricity is still unknown, and that the nomenclature used herein, such as "currents," "flowing," etc., are merely convenient technical terms to indicate certain known results.

The electric current induced by a mechanical generator—a dynamo—is necessarily alternating in character; that is, alternating in direction, so that the current, acting on an armature, first tends to actuate it in one direction and then reverses said effect and neutralizes such actuation. Such a current flows uninterruptedly and regularly, but rises in intensity from zero to maximum and falls from maximum to zero, and then repeats said variations in the opposite direction. Its curve of increase or decrease of strength is indicated by a wave line or sine curve.

Every mechanically generated current is naturally and originally an alternating current. Formerly it was not considered practicable to use mechanically generated currents until their alternations were straightened out by means of commutators which reversed the direction of the current so as to make it flow continually through the conductors. A current which is periodically reversed by a commutator which thus breaks the current between the changes in direction and takes off the current in sections, is known as a reversed or alternating current. This distinction between an alternating and an alternated current should be carefully noted. An alternating current continues to act in opposite directions as originally generated. An alternated current has been so reversed that the whole flows in one direction and is then known as a continuous current. When so reversed by commutators as to become continuous, the current loses certain characteristics essential to its highest efficiency.

Prior to the Tesla inventions, only reversed or alternated electric currents were used for the transmission of power. The application of this system for the transmission of power was limited, for various reasons; among others because a large current could not be safely used at sufficiently high pressure for long distances. On the other hand, the pure alternating current was practically unlimited in volume and pressure, and a change of pressure could be economically effected by the use of a transformer.

Prior to Tesla's inventions, however, these rapid alternations of the alternating current prevented the motor from starting its revolution and interfered with its continuing in operation, except when in synchronism with the generator. It was therefore impracticable for varying loads.

The problem which was presented to Nikola Tesla, and which he successfully solved was: How to overcome the difficulties attendant upon the use of the alternating currents so that their inherent vitality and untrammeled energy might be utilized for the unlimited transmission of power.

In an electric motor, the tendency of the armature is always toward the pole or point of maximum magnetic intensity. If a loosely-pivoted or freely-moving magnetic bar or armature be suspended midway between two coils of insulated wire wound in opposite directions on a soft-iron bar, and one of the coils is electrically energized, north and south poles will be formed at the ends of the soft iron bar—their location depending upon which coil is energized; but if both coils be equally energized, the two poles will neutralize each other and cause a resultant north pole midway between the coils. If, now, the current in one coil be made weaker than in the other, said pole will move toward the coil of greater electrical energy. The magnetic bar or armature will follow the shifting position of the pole, and by thus gradually varying the energy in the coils, the armature may be alternately caused to move from the pole of one coil along toward the pole of the other coil.

The alternating current generated by an electrical machine, as before stated, constantly varies from maximum intensity to zero in one direction, and then from zero to maximum intensity in the opposite direction.

In the invention of the patents in suit, Tesla availed himself of this characteristic feature of alternating currents in the following way:

In constructing a motor, he arranged on an annular soft-iron core, two pairs of magnetizing coils, each pair at right angles to the other, that is, one coil of one pair at the top and one at the bottom, and one coil of the other pair at each opposite side of said core, and mounted an armature in the centre. Then, connecting them with an alternating-current generator, he caused a current from one pole of said generator to pass through one pair of coils and a current from the other to pass through the other pair.

If the cycles of alternating currents be regarded as divided into 360 degrees, then, as shown in the Tesla illustrations, they will have a relative displacement of 90 degrees. In such position the lines of magnetic force traversing the two coils will be at maximum in one while at minimum in the other. This relative displacement marks the differing phase or time relation of the two currents.

The effect of passing two equal currents through said coils would be to cause the pole of maximum intensity to pass midway between the poles of the respective pairs of coils. But the effect of the ordinary operation of the generator as before explained was to cause the current in each pair of coils to vary from zero to maximum and to zero and then to shift in the opposite direction, the intensity of the current flowing to one pair of coils being at maximum while that of the other was at zero and one increasing while the other decreased, and the result being to shift said poles so as to make them travel entirely around said core.

Fifteen days after the issue of the patents in suit, Tesla read before the American Institute of Electrical Engineers a paper entitled "A New System of Alternate-Current Motors and Transformers," in which *inter alia*, he said:

"The transmission of power, on the contrary, has been almost entirely confined to the use of continuous currents, and, notwithstanding that many efforts have been made to utilize alternate currents for this purpose, they have, up to the present, at least as far as known, failed to give the result desired."

"The subject which I now have the pleasure of bringing to your notice is a novel system of electric distribution and transmission of power by means of alternate currents, affording peculiar advantages, particularly in the way of motors, which I am confident will at once establish the superior adaptability of these currents to the transmission of power and will show that many results heretofore unattainable can be reached by their use; results which are very much desired in the practical operation of such systems and which can not be accomplished by means of continuous currents.

"Before going into a detailed description of this system, I think it necessary to make a few remarks with reference to certain conditions existing in continuous-current generators and motors, which, although generally known, are frequently disregarded.

"In our dynamo machines, it is well known, we generate alternate currents which we direct by means of a commutator, a complicated device, and, it may be justly said, the source of most of the troubles experienced in the operation of the machines. Now, the currents so directed can not be utilized in the motor, but they must—again by means of a similar unreliable device—be reconverted into their original state of alternate currents. The function of the commutator is entirely external, and in no way does it affect the internal working of the machines. In reality, therefore, all machines are alternate-current machines, the currents appearing as continuous only in the external circuit during their transit from generator to motor. In view simply of this fact, alternate currents would commend themselves as a more direct application of electrical energy, and the employment of continuous currents would only be justified if we had dynamos which would primarily generate, and motors which would be directly actuated by such currents.

"But the operation of a commutator on a motor is two-fold; firstly, it reverses the currents through the motor; and, secondly, it effects, automatically, a progressive shifting of the poles of one of its magnetic constituents. Assuming, therefore, that both of the useless operations in the system, that is to say, the directing of the alternate currents on the generator and reversing the direct currents on the motor be eliminated, it would still be necessary, in order to cause a rotation of the motor, to produce a progressive shifting of the poles of one of its elements, and the question presented itself: How to perform this operation by the direct action of alternate currents? I will now proceed to show how this result was accomplished.

The claims in issue in Patent No. 381,968 are as follows:

"1. The combination, with a motor containing separate or independent circuits on the armature or field magnet, or both, of an alternating-current generator containing induced circuits connected independently to corresponding circuits in the motor, whereby a rotation of the generator produces a progressive shifting of the poles of the motor, as herein described.

"3. The combination, with a motor having an annular or ring-shaped field magnet and a cylindrical or equivalent armature, and independent coils on the field magnet or armature, or both, of an alternating-current generator having correspondingly independent coils, and circuits including the generator coils and corresponding motor coils in such manner that the rotation of the generator causes a progressive shifting of the poles of the motor in the manner set forth."

That of Patent No. 382,280, is as follows:

"The method herein described of electrically transmitting power, which consists in producing a continuously-progressive shifting of the polarities of either or both elements (the armature or field magnets or magnets) of a motor by developing alternating currents in independent circuits, including the magnetizing coils of either or both elements, as herein set forth."

The claims in issue of Patent No. 382,279, are as follows:

"1. The combination, with a motor containing independent inducing or energizing circuits and closed induced circuits, of an alternating-current generator having induced or generating circuits corresponding to and connected with the energizing circuits of the motor, as set forth.

"2. An electro-magnetic motor having its field magnets wound with independent coils and its armature with independent closed coils, in combination with a source of alternating currents connected to the field coils and capable of progressively shifting the poles of the field magnet, as set forth.

"3. A motor constructed with an annular field magnet wound with independent coils and a cylindrical or disk armature wound with closed coils, in combination with a source of alternating currents connected with the field-magnet coils and acting to progressively shift or rotate the poles of the field, as herein set forth."

Complainant's theory of the Tesla invention is shown in the following citation from the brief:

"It will be observed that to produce a shifting of the magnetic pole in one case, and a consequent movement of an armature corresponding thereto, each coil A and B must be traversed by a current of variable strength, and in order to secure uniformity of the movement of the pole or resultant it follows that the variations in strength of current in the two coils must be gradual and preserve definite relations to each other, throughout the cycle of variation in strength which the two currents undergo.

"This principle lies at the foundation of Tesla's brilliant discovery, the gist of which was the utilization of the alternating currents generated by an alternating-current dynamo or generator for effecting such shifting of the magnetic poles or resultant attractive forces upon the armature of a motor, and thus causing such armature to rotate in response thereto.

"His broad invention, expressed in a few words, was the production in a motor of a progressively-shifting magnetic field (or pole) by means of two

or more independent alternating currents, differing in phase, and circuits which preserve the independent character and phase relation of such currents."

Defendant's position is shown by the following extract from their briefs:

"Referring further to the apparatus of Tesla, Waterman says (Rec., p. 52): 'Briefly then, the apparatus consists of a ring field magnet having one set of coils tending to magnetize it on one diameter and another tending to magnetize it on a diameter at right angles to the first, and these sets of coils or circuits are so connected to a proper generator as to be traversed by currents such as would be generated by two coils at right angles to one another rotating in a two-pole field.' It will be seen from this that complainants claim a broad discovery and a broad invention based thereon. Defendants, on the other hand, contend that the alleged discovery was old, that its application was old, and that, since the days of Arago, there was never any room for a broad invention in the 'obvious' application of the alleged 'discovery;' and that the present state of the art has been developed from the earlier art including Arago's rotation by the mere application of engineering skill possessed by skilled electricians who have applied their knowledge as the progressive demands of the times called for it, supplemented by inventions special to the motor or the generator or the connecting circuits severally, and in no way entitling Tesla or any other patentee to prevent the sale of generators and motors through the ownership of an all-controlling patented 'system.'"

The well-known Arago rotation is described as follows:

"Arago's method of producing rotation in a copper disk consists of suspending it by its centre so as to make it lie horizontally above the poles of a horseshoe magnet and then rotating the magnet about a vertical axis. The rotation of the disk is due to that of the magnetic field in which it is suspended; and we should expect that if a similar motion of the field could be produced by any other means the result would be a similar motion of the disk."

The chief contention of the defendants is that there is no substantial difference in character between alternating and reversed currents and that the art of electric lighting illustrated in the alleged anticipations showed such an analogous use of reversed currents that the substitution of alternating for reversed currents did not involve invention.

Defendant further contends that the principle of reversibility was well known in the art, and as the inventors of electric lighting apparatus state that by a reversal of their action, power may be produced, Tesla is deprived of all claim to the exercise of the inventive faculty. That is, that the same apparatus may be used as a generator or dynamo-electric machine or may be reversed and used as a motor or electro-dynamic machine.

(This word "reversibility" has no relation in this connection to the word "reversed" as applied to currents.)

In support of their contentions defendants chiefly rely upon four prior publications, namely, the Baily article, of 1879; the Siemens patents, of 1878; Deprez's article of 1880-1884, and the Bradley application of May 9, 1887.

[The decision at this point quotes from different authorities at some length, from Siemen's British patent of 1878 for improvement in apparatus for dynamical production of electricity and its regulation when applied for illumination. The statement is also made that on May 9, 1887, about six months before the filing of the Tesla patents, Charles S. Bradley filed his application for his dynamo-electric machine, a generator for converting power into electricity. Judge Townsend continues as follows:]

A comparison of the Bradley application prior to Tesla with the Bradley patent issued subsequent to Tesla shows that in the former he described a method and illustrated an apparatus designed to obviate the objections to a two-phase alternating current by combining both currents in one by means of a transformer, while from the latter he omitted this description and method and inserted figures which, while strikingly suggestive of the apparatus shown by Tesla, failed to show that he conceived the Tesla idea or sought to secure the object of Tesla's invention.

For this reason, and further because Bradley's application is limited in scope, and ambiguous and indefinite; because it fails to show that he had any conception of the Tesla idea of "the utilization of the motor for the purpose of progressively shifting the magnetic poles of a plurality of alternating currents by circuits which preserved the independence and differing time relation of their phases;" because, even if the idea had been first conceived by Bradley, it was not sufficiently described to disclose the principle or method of operation; because Tesla was the first to reduce this principle to practice, Bradley does not anticipate or limit.

Defendants' chief reliance is on the Marcel Deprez publications of 1880-1884, and rightly so, for Deprez not only disclosed the principle which Tesla utilized, but he gave a mathematical demonstration of the rotating field. Complainant's expert's admission on this point is as follows:

"The article demonstrated mathematically the fact, which is also stated in the Tesla patents, that the polar line of an annular magnet may be shifted about through the entire circumference of the ring by the action of two magnetizing forces properly related."

[Judge Townsend here quotes from Deprez's writings, and then says:]

All that Deprez demonstrated, therefore, was that if a field was made in which the field magnet varied relative to the brushes, or *vice versa*, the angle of variation would be indicated by the needle in another machine which would move quickly or slowly as the brushes and magnets shifted relative to each other and would indicate the new angle subtended between the brushes and the magnet. The only useful, practical application of this device was to attach it to a machine which would produce currents, and to use the earth or a ship to indicate the shift of position by means of a needle on top of the mast. This apparatus failed to teach any one that alternating currents could be used as a source of power in a motor. It was a mere indicator. It did not involve the utilization of two alternating currents differing in phase as a source of power in producing a continuous magnetic field. It did not depend upon any constant, regular, progressive currents, and, so far as the evidence shows, it was like the apparatus of Baily, confessedly a mere laboratory experiment. That Deprez did not conceive of the Tesla idea of utilizing regular, progressive, constant alternations of current is conclusively shown by his own statement in 1884, after the publication of this paper and after the invention of the Gaulard and Gibbs alternating-current systems for lighting, when he published another paper in which he criticised the system and stated that one of the most serious objections to it was that it was not applicable to the transmission of power, and adds: "I must further remark that alternating currents are of no use in the transmission of power; they are suitable only for lighting purposes."

In fine, the evidence shows that, as Professor Silvanus Thompson says in his work on this general subject: "Deprez's theorem bore no fruit; it remained a geometrical abstraction."

The underlying thought disclosed and applied in the Tesla patents is such a use of the rapidly successive opposing alternations of the alternating current regularly and constantly recurring in such differing phases as would not only prevent the alternations from stopping the armature, but would become a source of power. It was essential to the practical development of this idea that the alternations should rise and fall and succeed each other progressively and constantly should be arranged, as counsel for complainant puts it, "like the crank on a locomotive in which there is no dead centre, but one crank is always pushing forward." Tesla's invention, considered in its essence, was the production of a constantly rotating or whirling field of magnetic forces for power purposes by generating two or more displaced or differing phases of the alternating current, transmitting such phases, with their independence preserved, to the motor, and utilizing the displaced phases as such in the motor.

Baily does not describe the use, with alternating currents, of displaced phases. He only describes the producing of intermittently shifting poles by means of a commutator or reverser which is just what Tesla disclaims. Neither Siemens nor Bradley describes the utilization of such displaced phases of alternating currents with their independence preserved in a motor.

Deprez describes a parallelogram of forces and its application to indicate at any given moment the angle between two parts of a source of current. He did not contemplate the use of alternating currents nor utilize their continuous and constant movement nor did he utilize said current to produce power, nor did he have any idea of a whirling field of forces to propel a motor.

What then was the status of the art in 1887 when Tesla filed these applications?

Nine years had elapsed since the grant of the Siemens patent which, according to counsel for defendants, "is a full disclosure of the subject matter in issue in Patents Nos. 381,968 and 382,280," and its "references . . . at the hands of the skilled electrician . . . would naturally, and as a matter of course, have resulted in an organization of elements constituting a system for the electrical transmission of power and embodying essentially the system" of said patents. Eight years had elapsed since Baily. It was four years since Marcel Deprez's article, according to defendant's counsel, "described the very thing that complainant claims is Tesla's discovery and explained the theory of operation," of an apparatus which "is an operative two-phase alternating-current generator supplying two-phase alternating currents to produce a rotating field in a motor" similar to the Tesla motor.

Prior to Tesla's invention no alternating-current motors were in use.

Although there has been an urgent demand for some practical means of utilizing alternating currents for transmission of power none had been found.

The continuous and unparalleled development of the electric art had for years increasingly emphasized the want of an electric motor capable of distributing power for long distances and had vainly called for the solution of the problem of the use of alternating currents for this purpose; the leading electricians of the day concurred with Deprez in his declaration after he had devised his comparateur that alternating currents could not be utilized in the transmission of power and that the future belonged to continuous currents.

In these circumstances Tesla patented his invention and thus first disclosed the method and apparatus, now generally known as the Tesla polyphase inventions, and introduced a new method, a new means and a new terminology into the art. Six months later he read his paper before the American Institute of Electrical Engineers and announced that previous efforts to utilize alternate currents had failed; that he had brought forth a novel system for the transmission of power, and explained its theory and demonstrated its operation by exhibiting a working motor; and no one of the electricians present questioned his claim or criticised his apparatus.

The statements made by electricians at said meeting are supported by abundant quotations from the contemporaneous literature of the day, and it does not appear that the recognition of Tesla as an original inventor of said system and of the means for its practical application was ever disputed until this suit was brought.

There is nothing in the record to detract from the claims then made. Tesla did not discover the parallelogram of forces; he did not discover the rotary field; but he was the first to explain how to do practically what Baily had said could be done by an impracticable infinity of magnets, and others had said it could be done, but without showing how it could be done. He harmonized the hitherto opposing alternations, while preserving their character and power.

Since the date of the Tesla patents in suit

there has been a revolution in the art due to the utilization of the means therein described.

The contention that the transfer from the electric light art to the electric power art did not involve invention can not be maintained.

Even if it be assumed that the art of electric lighting is in a sense analogous to that of electrical transmission of power, the result was new and unexpected. It has been already shown in what respects a reversed current differs from an alternating current. The question as to how far they are alike is of minor importance because it is admitted that the reversed or broken current is not the same for the practical purposes to which this invention is especially adapted. Therefore, although Deprez, in one of his publications, suggested that his system might be used for an impracticable and almost infinitesimal amount of power, the fact that these currents had never been practically used for any such purpose and can not, even now, be practically used for currents of high potential, shows that it required invention to select from an art that particular kind of current which was necessary for the production of the best results, and to adapt the mechanism of an art analogous or non-analogous, to its practical application.

The very fact that all the earlier electricians assumed or asserted that reversed and alternating currents were the equivalents of each other, was one of the errors which retarded the Tesla discovery, and the practical application of the polyphase principle.

The view most favorable to the contention of the defendants upon all the evidence presented, may be fairly stated thus:

Prior inventors had stated that electric light machines could be so reversed as to furnish power, although it is not proved that any one had shown a method for their use or the practical application thereof, or had ever made such practical application.

No prior publication explained how to utilize this alleged well-known reversibility and no prior machine applied it.

To the question why, if it was so obvious that the operation of the apparatus might be reversed and alternating currents then used, such method was not put in practical operation, the only answer of defendants is that "there had been up to 1885 no commercial system of distribution of alternating currents." But if this is so, is it not because the foremost electrical experts throughout the world had united in the opinion after repeated futile experiments that alternating currents were useless for the transmission of power and that the future belonged to continuous currents?

"The apparent simplicity of a new device often leads an inexperienced person to think that it would have occurred to any one familiar with the subject, but the decisive answer is that with dozens and perhaps hundreds of others laboring in the same field, it had never occurred to any one before." Potts *vs.* Creager, 155 U. S., 597.

Siemens, chiefly relied on to support this contention, does not describe any mode of using alternating currents, does not refer to the use of commutators, and only refers to the use of said apparatus as an electro-dynamic machine "with suitable modifications" which are nowhere described.

The impracticability as motors of reversed currents induced by commutators, shows that Siemens, Baily and others did not discover the Tesla invention; they were discussing electric light machines with commutators.

Tesla first stated the discovery how these alternations could be thus utilized and showed the machine and method adapted for this purpose. He is entitled to a patent for this discovery as were the discoverers of the use of anthracite coal instead of bituminous coal, or of the hot blast instead of the cold blast, in the manufacture of iron, or of the practical application of electricity to the telegraph or telephone. Judge Blacthford once sustained a patent for insulating electric wires by means of gutta-percha, and said:

"The gist of the invention is the discovery of the fact that gutta-percha is a non-conductor of electricity, and the application of the fact to practical use. The claim is valid, even though a metallic wire covered with gutta-percha existed before the plaintiff's invention, if it was not known that gutta-percha was a non-conductor of electricity, and could be used to insulate the wire." Colgate *vs.* Western Union Telegraph Company, 6 Fed. Cases, 86.

It is not necessary to go to this extent in sustaining these patents. The complainant may safely rest its case on the general principles laid down in the various decisions of the Supreme Court and extended and developed in Potts *vs.* Creager, *supra.*

But if the evidence already considered be disregarded, and it should be assumed that alternating and alternated currents were theoretically-known equivalents, even then the argument for counsel for defendants does not appear to be sound. They contend that a superior result, by reason of the substitution of one known equivalent for another, does not constitute invention. But the first substitution or application of such theoretical equivalent to produce a new or non-analogous or unexpected result, may involve invention. Tesla applied the alternating current to do what the alternated current had never before done; namely, to produce a new, unexpected and practical system of transmission of power.

A careful study of the evidence has led to the conclusion that Tesla made a new and brilliant discovery. But even if this be incorrect, it is proved that by a new combination and arrangement of known elements, he produced a new and beneficial result never attained before.

The technical defense of non-infringement by reason of the fact that defendants use only a motor, and that there is no allegation or proof of conspiracy with the owners of the plant which supplies the power, was not pressed on the argument, and, as six days were spent in the discussion of the questions on the merits, this point will not be discussed.

If any amendment is necessary to cover these points it should be allowed.

The contention of defendants that Tesla does not describe an operative machine, is not satisfactorily proved. It is proved that, in fact, several practical motors have been manufactured according to his invention.

The model of the particular patented construction selected for this proof, claimed to correspond most nearly to defendants' construction, failed to show a capacity of self-starting, and, when once started, revolved in either direction; but complainant showed on the hearing various differences between the construction shown in the drawing of the patent and the model, which, it was claimed, accounted for the failure.

The defendants use a three-phase transmitting system comprising a three-phase generator, three transformers and a three-phase motor. The argument based on the use of transformers was not pressed. . . .

The serious question raised in this branch of the case is as to the construction of the word " independent" in the patents. Counsel for defendants contends that "the word used in the patent evidently refers to the physical relations which exist and not to any result produced." Counsel for complainant contends that Tesla's "broad invention . . . was the production in a motor of a progressively shifting magnetic field by means of . . . independent alternating currents differing in phase, and circuits which preserve the independent character and phase relation of such currents."

The specifications and drawings of said patents describe and show six independent transmitting wires which are repeatedly referred to as constituting independent circuits, and the claims emphasize this independency. In defendants' motor the coils of generator and motor are so interconnected that each line wire not only serves as a conductor for its own phase, but also for the other currents.

Defendants' contention is fairly stated by counsel for complainant as follows:

"The defendants contend that currents of electricity belonging to each of the circuits are, therefore, at times all flowing in the same wire or wires, and that at certain instants in the operation of the same; *i. e.*, when each of the single transmission wires is, for an incredibly short period, transmitting no potential (*i. e.*, change from plus to minus)—two of the coils of the motor are supplying current to the third. . . . They cite the admission of Mr. Waterman that 'analytically' it is perfectly true that currents of electricity of differing phase may be at times regarded as simultaneously flowing in the same circuit."

This statement of Waterman, however, should be read in connection with his further statement, as follows:

"The net result of it all is that in a manner more or less complex to follow, these electromotive forces so cancel out that there is in each circuit a current differing in phase by 120 degrees from the current in each of the others, so that in the motor it is not possible to tell how the current got there, or over what kind of a circuit. (*i. e.*, whether over a three-wire or a six-wire circuit.)"

Counsel for defendants argue:

"That the term independent as used by Tesla means such separation as is consistent with having the complete circuits traversed by the same currents—currents which at any and every point are of the same quantity, intensity and phase, so that, as Mr. Clarke puts it, each motor circuit receives its current from a corresponding generator circuit and from no other. It can not refer to circuits which are interdependent in such sense that two of the circuits are at times strictly in series with one another and in multiple with the third, and so are not 'independent' in any sense. The whole system is an interdependent and not an independent system."

The following significant statement, however, is found near the end of the specification of the first patent, No. 381,968:

"By 'independent' I do not mean to imply that the circuits are necessarily isolated from one another, for, in some instances there might be electrical connections between them to regulate or modify the action of the motor without necessarily producing a new or different action."

The claims, therefore, confessedly can not be read as requiring isolation of the circuits but at most only such independence as is necessary for the purpose of producing a rotary field; that is, the connections must be such as not to interfere with the independency of the circuits which operate to shift the poles.

The only practical result from defendants' use of three conductors instead of six is an improvement "to regulate the action of the motor," which result was anticipated by Tesla as above, and it is proved that it was known in the prior art that one of these arrangements was a substitute for the other.

Inasmuch as the defendants have not invented any new idea, but have adopted an old contrivance which performs the same result in substantially the same way by a formal and unsubstantial change in means, and by circuits which, while in some sense interdependent, are operatively independent, and which preserve and utilize the vital element independence of phase, these circuits must be held to be the equivalents of the independent circuits of the patent, the word independent being interpreted to mean operatively independent, so as to embrace the true spirit and essence of the Tesla invention.

This conclusion is supported by a great number of illustrations of similar uses of such independent conductors in the general field of the arts. As the expert for complainant has pointed out, in railroads, cash carriers, electric telegraphs, the tracks, the earth or a single wire, will serve as common but independently-acting conductors.

It does not seem necessary to further discuss this contention based on a technical verbal distinction.

Defendants' three wires are operatively independent; they are actually independent while in action; they are independent enough to do the required work.

This case involves a diversity of complicated questions of the scope and effect of certain language, of the prior art, and of the operation of electrical apparatus. All these questions have been exhaustively discussed with singular ability and learning by the able counsel herein.

If the contentions of defendants as to the scope of the patents in suit are proved the question of infringement of the patented independent circuits is not free from difficulty. If independence means isolation the patents are valueless. But if complainant's contention is correct, and if Tesla is entitled now

to the broad claim which no one denied when he announced it to the American Institute of Electrical Engineers as his "novel system of electrical distribution and transmission of power by means of alternate currents . . . which will at once establish the superior adaptability of these currents to the transmission of power and will show that many results heretofore unattainable can be reached by their use," then there can be no question that defendants have infringed. The foregoing language has been again quoted in order to emphasize how consistently at the end of 10 years after a review of all possible questions Tesla stands upon his original statement of invention.

Infringement of the first claim of Patent No. 381,968, necessarily implies infringement of the method Patent No. 382,280. The finding that the circuits of the defendants are independent, in the sense of the Tesla patents, is decisive against the defendants as to the infringement of the first and second claims of Patent No. 382,279; and the field magnet of defendants' motor, while differing in some respects from that of the third claim of No. 381,968, is annular or ring-shaped within the meaning of said claim and infringes it.

At the close of the defendants' brief is printed the "Decision of the Imperial Court of Germany on Tesla Patent." The only reference thereto in said brief is in the statement that in said suit "brought to obtain a cancellation of Tesla's patents, that a German patent to one Haselwander (including the rotary-current system employed by defendants) was partially annulled because of the publication of this American patent to Bradley" and in the following statement:

"It should also be mentioned that the Imperial Court held that the system employed by defendants does not infringe the German Tesla patent corresponding to the patents involved in this suit —that court holding with us that our system is a dependent system and not having the independent circuits of the Tesla patents and inventions."

It is somewhat difficult to determine, from said opinion, the scope of the issues involved, but it appears that some German firm had applied to have two Tesla German patents canceled on the ground that they have not been worked, but "have only been used to the disturbance of the electro-technical industry in Germany." Tesla, as defendant, admitted that he had not actually worked his invention, but had fulfilled his duty by a license to a firm which had pledged itself to work the patents, and, furthermore, that certain alleged infringers, by using a rotary-current, three-wire system, which seems to have been substantially like that of defendants herein, had "worked" his invention, and thereby saved him from the statutory penalty. The court held as follows:

" 'By independent is not meant to be expressed that the circuits are necessarily insulated from each other, since in single cases electrical connections can exist between them in order to regulate the working of the motor, without necessarily producing a new or another manner of working,' then also nothing is gained for him thereby. Entirely disregarding the fact that after the striking out of the sentence, which clearly occurred in order to avoid unclearness, the independence of the circuits is only so to be understood as is shown from the drawing and description—namely, as conditioned by a completely independent outgoing and return conductor—there would also never be able to be read into the stricken-out sentence that therein the linking of the circuits in the meaning of the rotary-current system had been thought of, for this linking removes the independence of the circuits, while the erased sentence will only admit such connections as permit the independence of the circuits to exist."

But this statement is a mere *obiter dictum*. The explanatory language relied upon by complainant in the patent here in suit has been stricken out of said German patent. The decision was upon two patents not shown to be the same as those herein in suit; the applications therefor were not filed until May, 1888, and not until after the Tesla invention had been described in a printed publication. But even this decision is to be construed as insisting upon a construction unfavorable to that here contended for by complainant, it should only be considered in connection with the foregoing facts. Here, the question of independence is directly presented, on a different issue, in view of a different state of the art, upon a different patent, from which the explanation of the word "independent" has not been erased. No sufficient reason has been shown why the conclusion of the German court should be followed in determining the question of infringement herein.

The search lights shed by defendants' exhibits upon the history of this art only serve to illumine the inventive conception of Tesla. The Arago rotation taught the schoolboy 50 years ago to make a plaything which embodied the principle that a "rotating field could be used to rotate an armature." Baily dreamed of the application of the Arago theory by means of a confessedly impossible construction. Deprez worked out a problem which involved the development of the general theory in providing an indicator for a ship's compass. Siemens failed to disclose the "suitable modifications" whereby his electric light machine might be transferred into a motor, and Bradley is almost equally vague. Eminent electricians united in the view that by reason of reversals of direction and rapidity of alternations an alternating-current motor was impracticable, and the future belonged to the commutated continuous current.

It remained to the genius of Tesla to capture the unruly, unrestrained and hitherto opposing elements in the field of nature and art and to harness them to draw the machines of man. It was he who first showed how to transform the toy of Arago into an engine of power; the "laboratory experiment" of Baily into a practically successful motor; the indicator into a driver; he first conceived the idea that the very impediments of reversal in direction, the contradictions of alternations might be transformed into power-producing rotations, a whirling field of force.

What others looked upon as only invincible barriers, impassable currents and contradictory forces, he seized, and by harmonizing their directions utilized in practical motors in distant cities the power of Niagara.

A decree may be entered for an injunction and an accounting as to all the claims in suit.

Science Brevities

Cause of Terrestrial Magnetism—An interesting attempt to reduce the phenomena of terrestrial magnetism to electric convection currents has been made by Mr. W. Sutherland, in a paper in *Terrestrial Magnetism,* thus abstracted by the *Electrician.* He supposes that the primary magnetic field of the earth is produced by a surface charge of negative electricity, which revolves with the earth, and whose motion through the ether produces the magnetic field. Astronomically, however, the earth does not act as a negatively-charged body, as its surface charge is compensated by an equal positive charge at the centre. The author shows that the surface density required would be 51,000 electrostatic units. The magnetic field outside the earth would be the only external evidence of the existence of the electrostatic field within. Secular variation is accounted for by a dissymmetry of the conductivity of the earth's crust, which induces a transverse field and produces a potential similar to that of Barons's hypothetical transverse magnet. As regards the daily variation, the author points out that the process of dissociation induced by the sun in the upper strata of the atmosphere would produce a downward current of positive ions, and this would be the earth-air current to which the diurnal and other short-period variations have already been attributed. The currents are closed by flowing along the surface of the earth from equator to pole, by the glow discharge of the aurora in polar regions, and in the upper atmosphere by flowing from the pole to the equator.

Coherence in Incandescent Lamps—A curious phenomenon has occasionally been observed in the glow lamps on the circuits of the Calcutta Electric Supply Company at times when Calcutta has been visited by exceptionally severe thunderstorms, says the *Electrician.* Immediately following each lightning flash the brightness of the glowing lamps has been observed to increase suddenly gradually returning to the normal incandescence. This phenomenon has so frequently been observed that the engineers of the company have sought every possible explanation of the curious phenomenon, but have been unable to find any defect in their circuits—which are on the overhead wire system—that might offer an explanation. Indeed, the only conceivable explanation is one which appears so extraordinary that many may find considerable difficulty in accepting it. It is well known that carbon, acting as a coherer in a wireless telegraph apparatus, undergoes the usual sudden decrease in resistance when subjected to electric radiation. It is possible that the carbon filaments of a glowing lamp may undergo a similar change when exposed to the influence of a tropical thunderstorm in its immediate vicinity. This sudden decrease in the resistance of the filament would, of course, produce a correspondingly rapid increase in its candle-power, after which the gradual self-decoherence of the carbon would account for the return of the lamp to its normal incandescence. We are not aware that this remarkable effect has been detected in any other electric supply circuit, but should this have been the case it might further elucidate the phenomenon if the engineers who have observed it would now make the facts public.

It is expected that by October 1 trains on the third-rail electric system will be running on the Second and Ninth avenue lines of the Manhattan Railway Company in New York city.

A New Electric Air-Brake System.

In these days of heavy-weight and high-power electric cars there is a constantly increasing field for power brakes. Of the numerous varieties of power brakes that have been applied to such service none seems to have given better results than the type operated by compressed air, which ensures a positive and powerful motion.

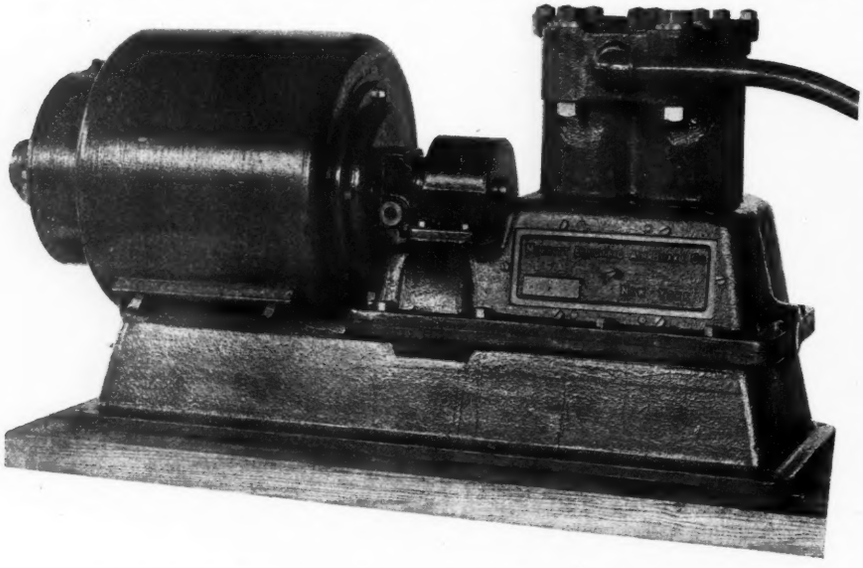


FIG. 1.—MOTOR-DRIVEN AIR COMPRESSOR FOR ELECTRIC AIR-BRAKE SYSTEM.

The illustrations herewith represent a new system of electrically controlled air-brakes, designed with especial reference to use on electric cars. The air-brake system employed is of the positive variety, compressed air being admitted directly by the controller mechanism to the brake cylinders under the cars, while the supply of compressed air itself is supplied by an electric motor-driven air-pump.

The air compressor, which is shown in Fig. 1, is of the motor-driven, duplex, single-acting pattern designed after a careful analysis of the requirements, and is built in six sizes ranging from two to ten horse-power. The motor is a multipolar series machine, entirely enclosed so as to make it practically dust and waterproof, and is fitted to a cradle forming a part of the compressor base. Its armature may be removed without disturbing any part of the air compressor. These machines are designed to operate under a normal speed of 750 revolutions per minute of the motor shaft, geared down at a ratio of four to one, and are of such size that they may easily be installed under the seat on one side of a side-seat car, or swung under the body of a cross-seat car. It is generally arranged to operate up to a pressure of about 60 pounds per square inch, the air being compressed into a proper receptacle or tank. From this receptacle the air is admitted to a "jam-cylinder" of the usual type connected with the brake mechanism. The valve for controlling the air pressure possesses peculiar properties which are claimed by the makers, the Merritt Electric Air Brake Company, New York, to be unique in this line of work. The movement of the stem of the valve admitting air to the brake cylinders is controlled through a simple crank and link motion by means of a handle operated by the motorman. When this handle is turned to admit air to the brake cylinder it opens the air valve against the pressure of the compressed air in the tank and admits the air to a large chamber forming the central part of the valve mechanism. Naturally, the pressure in this chamber rises instantly, with the effect that, operating on the large piston forming the back side of the valve, it shuts off the supply of air and leaves the pressure in the brake cylinder practically determinate for any given position of the control handle. A number of ingenious devices have been combined with this valve whereby the cooling of the air and the condensation of moisture or the formation of frost in the valve in cold weather are definitely obviated. Provisions have also been made to guard against any action of a leak in the main air valve, which might otherwise have the effect of applying the brakes unintentionally.

Perhaps the most ingenious feature of the system is found in the controller which actuates the motor driving the air pump. As is well understood, a motor of this character operates whenever the pressure in the air tank falls below a predetermined amount and continues to operate until the pressure rises to its definite maximum. In Figs. 3 and 4 are shown the controller by which the movements of the motor are governed. Referring to the plan view on the lower or right-hand side, the air pressure of the tank is admitted against a spring controlled piston which operates a small D-valve. Naturally, as the pressure in the air tank increases slowly so long as the motor pumps, the movement of the piston in this cylinder is correspondingly slow and the D-valve mentioned uncovers its ports slowly. These ports communicate with the left-hand or upper cylinder as shown in the illustration, causing its piston to move rapidly forward or back as the case may be. The function of this piston is also to control a valve connected with the middle cylinder of the apparatus, this valve being, however, of a simple form and practically equivalent to half of a D-valve; in other words it admits air to the bottom of the middle cylinder or else opens this cylinder to the free air and permits the spring in it instantly to elongate.

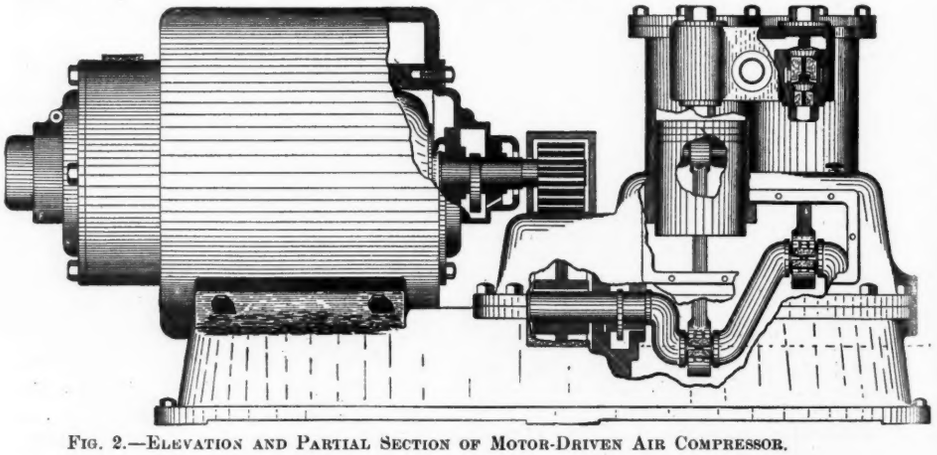


FIG. 2.—ELEVATION AND PARTIAL SECTION OF MOTOR-DRIVEN AIR COMPRESSOR.

Connected with the spring in the middle cylinder is a piston rod carrying on

its end a cross-piece having two U-shaped springs which engage with similar springs on the terminals of the apparatus, as clearly shown by the illustration. If the pressure in the tank falls too low the spring in the first cylinder throws back the valve so as to connect one side of the piston in the second cylinder with the high pressure air in the tank. This piston quickly moves so that the valve in its cylinder opens the bottom end of the middle cylinder to the free atmosphere permitting its spring quickly to throw into contact the U-shaped connectors mentioned above. This starts the motor and pump, which proceeds to pump until the pressure in the air tank rises to the predetermined point, which may be regulated by the thumb-nut shown on the outer or right-hand end of the cylinder. So soon as the air pressure has sufficiently pressed the governing spring in the cylinder, the D-valve operates to release the pressure on one side of the piston in the second cylinder and turn in the pressure on the other side, causing it quickly to throw over its valve and admit compressed air to the bottom of the middle cylinder; this instantly throws out the electrical connections between the two terminals on the board, but while the U-shaped springs are leaving their seats, carbon contacts, clearly shown in the illustration, are still engaged with one another, and in consequence the small spark formed is drawn between these rather than between the metallic contacts. A feather on the piston-rod of the middle cylinder prevents any rotation of the moving parts and secures the alignment of the contact bar with its seats in the terminals.

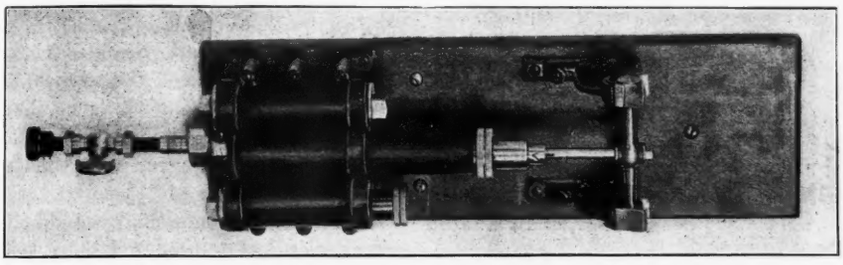


FIG. 3. CONTROLLER SWITCH FOR ELECTRIC AIR-BRAKE SYSTEM.

The whole system has been carefully worked out and all its parts designed with reference to their use in combination with one another. Great credit is due to the company for the excellent and practical design which has been developed for this particular type of apparatus.

The Merritt Electric Air Brake Company's offices are at 20 Broad street, New York, and its works are located in Roebling street, Brooklyn, N. Y. The officers of the company are C. M. Englis, president; J. C. Gilbert, vice-president; William M. Hoagland, secretary and treasurer. Equipments are now being supplied to several leading electric railways which have placed contracts for this air brake equipment. The company is making preparations to exhibit the equipment at Kansas City during the convention of the American Street Railway Association in October.

National Electric Light Association.

TO THE EDITOR OF ELECTRICAL REVIEW:

I hand you herewith copy of a letter sent out by President Cahoon to central stations that are not members of the association. We have added several members to our list as a result of this letter. It will be followed very soon by another appeal, and it is the intention to keep the matter before the different lighting companies throughout the country until they are all convinced of the advantages of a membership in the association. In the meantime, we would ask you, as fellow members, to do all in your power to assist in strengthening the association. As the association has no revenue except that derived from dues, its power for good work is naturally in proportion to our numbers. Thanking you in anticipation of whatever influence you may be able to exert in this direction.

GEORGE F. PORTER,
Secretary.

New York, September 13.

President Cahoon's letter is as follows:

The work of the National Electric Light Association has broadened to such an extent as to be of vital interest to every electric light company in the country, and we are now confronted with great problems demanding an ample supply of funds for their proper solution.

The work of our committee on Photometric Value of Arc Lamps has been of a remarkably high order, and to carry it to its logical conclusion will require an increased fund.

The association has taken an aggressive stand against municipal ownership, and is daily helping companies, particularly small ones, in their fight for existence. Companies not members of the association do not hesitate to appeal to us for help when attacked, yet seem to think that we should go to the expense of collecting and preparing data for their use without expecting them to help foot the bills.

The association has now in hand the preparation of a complete and uniform system of accounting; is preparing to fight the present unjust freight classification of electrical apparatus; is engaged in the collection of data of vital interest, and is doing much other work that will benefit you as well as our members. The time has come when, in order to broaden still further our sphere of usefulness, we need your active support and co-operation. To become a great power for the safeguard and welfare of our members, and to present a strong front and successfully beat back the wave of municipal ownership now rapidly extending over the country, we must unite for the common defense. I therefore ask that you do your share by joining the association; not at some time in the future, when it may be too late, but *now*. The annual dues are so small—only $25—that there is not an electric light company in the country but can pay them and not feel it. A brief letter of application, with check, is all that is necessary. *Will you not send this in at once?*

Very respectfully,
(Signed) J. B. CAHOON,
President.

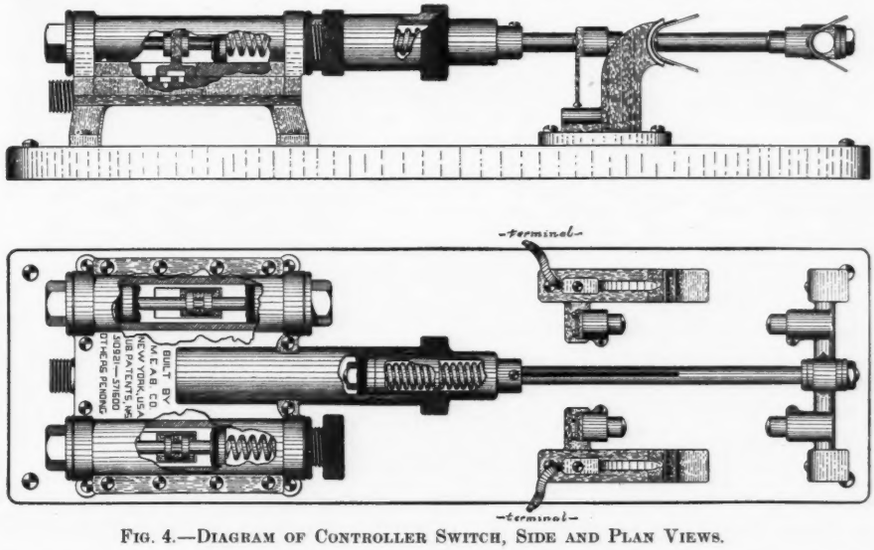


FIG. 4.—DIAGRAM OF CONTROLLER SWITCH, SIDE AND PLAN VIEWS.

Compression Splices for Cables and Wires.

In the development of this new method of splicing, under the patents of Mr. T. J. McTighe, the well-known electrical engineer, the Splice and Terminal Company, of New York city, has produced some very striking apparatus. Some time ago the ELECTRICAL REVIEW illustrated the apparatus for splicing large feeder cables, the hydraulic pump being located on a small truck with a crane attached, allowing the 75-ton press to be lowered readily into a manhole for splicing the feeder-cables which occupy the ducts of underground conduits.

Since then the company has brought out several smaller sizes of both press and pump. The accompanying illustration shows the No. 3, or 20-ton press, with independent hydraulic pump and flexible connection. The apparatus is very compact and has several striking features. Though easily capable of exerting a pressure of upwards of 40,000 pounds, the press alone with its splicing dies, weighs only 14 pounds. The pump weighs 15 pounds and the connector and its couplings less than a pound. This size is for splicing or tapping No. 0 cable or wire and smaller sizes. The actual operation of swaging down the splicing sleeve or branch "tee" takes but one-half minute. This type and size of apparatus is especially adapted for interior wiring of buildings, enabling the whole of a large office building to be wired without using an ounce of solder, and without applying heat anywhere, or damaging insulation in the slightest degree.

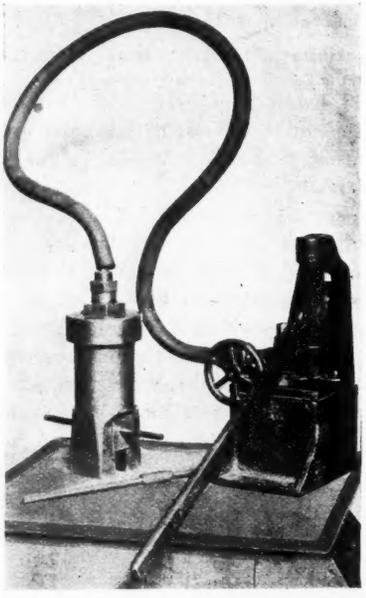
The whole outfit weighs less than the ordinary solder pot and furnace or blast lamp. The splicing can be done between a cable and a wire, or between two cables of different sizes, branches can be connected to the main at any point, or the latter may be split by a compression "Y" where desired.

By merely changing the dies, this same press serves admirably for attaching to No. 0 cable or smaller, any of the ordinary forms of terminal blocks for connection to switchboards or other apparatus. An important feature of the apparatus is the flexible connector. In outward appearance it is merely a piece of rubber hose about three-fourths inch in diameter, and of about the same flexibility; yet, when in operation, this connector carries a pressure of 10,000 pounds per square inch. And while under that tremendous pressure, the connector is as readily bent or coiled as a piece of hemp rope of same diameter. The ELECTRICAL REVIEW is not at liberty to disclose the construction of this hose for the present. It will probably be found useful by contractors and others requiring a hose capable of safely carrying high pressures.

The Morris Electric Company, of New York, is handling the business of the Splice and Terminal Company, and reports a most satisfactory outlook.

Electromobile Ambulances.

Within a few days Roosevelt Hospital, in New York city, will have for its ambulance service two electric ambulances. They are able to travel 16 miles an hour, weight 4,800 pounds each, and cost about



PRESS FOR MAKING COMPRESSION SPLICES IN WIRES AND CABLES.

$3,000 each. They are gifts to the hospital, a prominent physician of New York giving one of the ambulances. They will be put into service just as soon as the necessary mechanical arrangements are completed in the stable of the hospital. The only vehicle of the kind now in use in the city is owned by St. Vincent's Hospital. The three ambulances were manufactured by a firm in this city which is now constructing similar ambulances, one for the New York Hospital and one for the Presbyterian Hospital. The ambulances intended for Roosevelt Hospital are seven feet six inches long on the inside, this being 18 inches longer than most ambulances, and have room for three reclining patients, while eight can be crowded in if they are able to sit up. The physician, instead of sitting at the back of the ambulance, will sit at the left side. There are windows of plate glass, so that the physician can look out on either side. He can speak to the driver through a speaking tube.

Wall Street and the Electrical Stock Market.

The stock market continued extremely dull throughout the current week and at the close to-day was subjected to severe pressure. Substantial declines appeared in practically every quarter. There was scarcely any feature of interest developed during the week.

On the New York Stock Exchange, General Electric closed the week at 137 bid and 139 asked, indicating no change for the week. Metropolitan Street Railway, of New York, closed at 149 bid and 149½ asked, a loss of 5½ points for the week. Third Avenue Railroad, of New York, closed at 110 bid and 111 asked, a loss of 1 point for the week. Brooklyn Rapid Transit closed at 52½ bid and 52⅝ asked, a loss of 2 points for the week. Manhattan Railway, of New York, closed at 88 bid and 88⅛ asked, a loss of 3⅞ points for the week.

On the Boston exchange, American Telephone and Telegraph closed at 142 bid and 143 asked. Erie Telephone closed at 97 bid and 98 asked.

On the Philadelphia exchange, Electric Storage Battery was not quoted. Electric Company of America closed at 8¾ bid and 9 asked. Union Traction closed at 34⅝ bid and 34⅞ asked, a loss of 1⅞ points for the week.

On the curb, or outside market, in New York, Electric Vehicle closed at 21 bid and 24 asked, a gain of 2 points for the week. Electric Boat closed at 16 bid and 20 asked, a gain of 1 point for the week.

Wall street, September 8.

Telegraphers and Typewriters of America.

Mr. Charles P. Bruch, assistant secretary and assistant general manager of the Postal Telegraph Cable Company, New York, desires the ELECTRICAL REVIEW to state that the Postal Telegraph Cable Company has not indorsed an organization calling itself the "Telegraphers and Typewriters of America," and that any references to Mr. Bruch in connection with the association are unauthorized. Mr. Bruch states that the association is soliciting donations and advertisements for a souvenir programme and that he is informed that the canvassers are making statements to give the impression that the Postal Company indorses the organization and that he is interested in it.

BOSTON, MASS.—The Simplex Electrical Company has filed a certificate of increase of capital stock to the amount of $100,000 with the Secretary of the Commonwealth.

International Association of Municipal Electricians.

As already announced, the fifth annual meeting of the International Association of Municipal Electricians will be held at Pittsburgh, September 25 to September 27, inclusive. Mr. F. C. Mason, of Brooklyn, N. Y., has arranged for a special car on the Baltimore & Ohio Railroad to leave New York, at the foot of Liberty street, at seven oclock, P. M., on Sunday, September 23. This will carry the delegates from New York and Brooklyn and vicinity. A special rate of one and one-third fare has been granted by the Trunk Line Associations. Mr. Mason invites all who wish to go on this special car to meet him at the Astor House, New York city, at five P. M., on September 23. The railroad will have an agent present to supply tickets. For sleeping car accommodations delegates are requested to address Mr. Mason at the Police Telegraph Bureau, 16 Smith street, Brooklyn, N. Y., before Friday, September 21.

A Substitute for Hard Rubber.

Mr. H. W. Morgan, of Meriden, Ct., informs the ELECTRICAL REVIEW that he has invented a substitute for hard rubber called "ceregum." It is said to be derived from a new and cheap source, is produced by chemical processes, is claimed to be cheaper than any form of hard-rubber compound of fair quality, will vulcanize in an ordinary oven without moisture, and can be used with rubber in any proportion desired. As it will vulcanize of itself, it forms a valuable alloy for rubber. The cost of the material makes its use possible for many purposes where rubber can not be afforded. The material will soon be placed upon the market in sheet, rod and tubular forms.

A New Water Motor.

In the accompanying illustrations is shown a new water motor called the "Demon," manufactured by Mr. P. Pitman, of Halifax, Yorkshire, England. Mr. Pitman has had considerable experience in the design and manufacture of water motors and this is one of his latest types. The recent improvements in this motor consist in a number of bifurcated or double buckets of special construction, bolted to the rim of the wheel. The water issuing from a round nozzle strikes the buckets in the centre when it is deflected equally to both sides. The water issues from the driving pipe with the full velocity due to the head and glides along the concave surface of the wheel buckets, thus acting entirely by impulse. In order to enable the water to leave the buckets at the least possible velocity, the buckets are widened at the sides as shown in Fig. 1, where A B is the relative water path in the bucket. It will be observed that the actual amount of wet surface is extremely small. After considerable experiment the type of bucket giving the best results under a moderate or high pressure has been shown to

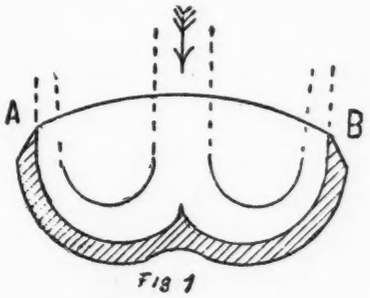


Fig 1

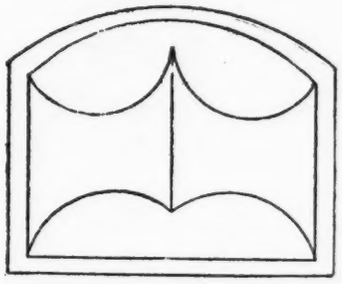


Fig 2

FIGS. 1, 2 AND 3.—A NEW WATER MOTOR.

be those shown in Figs. 1 and 2. This water motor runs at very high speed and its available power may be increased by enlarging the nozzle.

The "Electrical Review's" Telephone Number.

This is to inform the friends of the ELECTRICAL REVIEW that its telephone number has been changed from "1546 Cortlandt" to "21 Cortlandt." A private branch exchange connecting all departments has been installed in the new offices in the Park Row Building, 13-21 Park Row, New York.

Views, News and Interviews

As a result of numerous hold-ups on the lines of the local street railways in Omaha, Neb., the company has made a standing offer of $500 for every dead bandit produced at the coroner's office, and for every live one produced at the county jail $250. The conductors of many of the trains in the suburbs have provided themselves with guns carrying 16 buckshot to each charge. Street cars running down the main street of Omaha with conductors carrying repeating shotguns are one of the evening sights of the city.

The "Twopenny Tube," as the new underground railroad in London is called, is proving a great success, and this seems to be largely due to a press agent employed by the road. An American electrical engineer, now in London, writes to the ELECTRICAL REVIEW as follows: "The great success of the Central London is just waking things up. The line has an advertising agent that is a corker. He succeeds in getting an article into each of the daily papers every day, and besides this he has an editorial about once a week; then he has a topical song in each music hall every night. The consequence is that the 'Twopenny Tube' is the talk of the town and its receipts are beyond expectation." Our correspondent further states that there is going to be an immense amount of electrical work done in London in the immediate future.

Katie is just over and she is employed as a domestic in a big house surrounded by shade trees on the Cass farm, says the Detroit *Free Press*. She is as willing as a hungry mosquito, but there are things she has not yet learned.

Katie is having a hard time in mastering the telephone. She has had many lessons and long, but there is a mystery about the whole thing that inflames her superstition.

"Any one call or ask for me by telephone while I was out, Katie?" asked the mistress.

"Indade they did, mum. The box jingled and a lady wid a voice like a coffee mill says, 'Hello,' and I says, 'Hello yerself,' and she says, 'Who is this?' and I says 'None of yer business.' And she says, 'Is Aunt Mary there?' And I told her she'd betther ask a policeman, and she foired sumthin' in my ear, and I dared her to show the ugly mug of her back of our barn and she said nuthin'. I'll talk in that machine no more, mum."

Corporation News

WHITEHALL, N. Y.—The Whitehall & Granville Railroad Company, of Washington County, has been incorporated to operate a street surface railroad by electricity or other power, except locomotives; capital, $750,000.

TROY, OHIO—The Troy Electric Leasing Company, of Troy, has been chartered to buy and sell electric machinery, etc. Capital, $25,000; incorporators: C. C. Hobart, W. H. Coles, H. L. Johnston, Adeline I. Johnston, I. Rhodes.

BATAVIA, OHIO—The Batavia Telephone Company, of Batavia, has been incorporated to construct and operate telephone lines. Capital, $5,000; incorporators: W. R. Walker, J. W. Ransom, J. C. Ward, W. H. Baum, O. P. Griffith.

ATHENS, OHIO—The Athens County Telephone Company, of Athens, has been chartered to construct and operate a telephone line. Capital, $15,000; incorporators: C. L. Jones, G. W. Duffee, W. E. Moler, A. F. Holmes, E. J. Holmes.

IRONTON, OHIO—The Lawrence Telephone Company, of Ironton, has been incorporated to construct and operate telephone lines. Capital, $24,000; incorporators: W. B. Seaton, J. L. Anderson, H. Russell, T. L. Collett, F. E. Hayward.

CANTON, OHIO—The Stark County Telephone Company, of Canton, has been incorporated to construct and operate telephone lines. Capital, $100,000; incorporators: F. Herbuck, R. S. Shields, H. W. Detmering, A. Dannemiller, H. A. Cavnah.

MINERAL CITY, OHIO—The Mineral City Home Telephone Company, of Mineral City, has been chartered to construct and operate a telephone line. Capital, $12,000; incorporators: G. J. Markley, T. E. Wilson, E. Vankirk, J. L. Kenedy, C. D. Juvinall.

CURWENSVILLE, PA.—The Curwensville Electric Company, of Curwensville, has been chartered for manufacturing and supplying light, heat, etc. Capital, $10,000; incorporators: A. E. Patten, E. A. Irvin, F. J. Dyer, W. F. Patten, J. A. Frank, all of Curwensville.

SHAMOKIN, PA.—The Shamokin & Edgewood Light, Heat and Power Company, of Shamokin, has been chartered to supply light, heat and power. Capital, $30,000; incorporators: M. H. Kulp, G. G. Kulp, D. C. Kaseman, H. W. Shuman, W. J. Wiest, J. Reed, all of Shamokin.

SHARON, PA.—Penhale & Fisher, of New York, have financed a traction scheme whereby the Youngstown & Sharon Railway Company is to erect a line between Sharon, Pa., and Youngstown. W. H. Park, of Youngstown, Ohio, is president; J. C. Whitia, Pittsburgh, vice-president, and Senator B. F. Wirt, Youngstown, Ohio, secretary and treasurer.

SANBORNTON, N. H.—The Sanbornton Telephone Company, of Sanbornton, has been incorporated to operate a telephone line. Capital, $1,150; incorporators: J. N. Sanborn, W. B. Sanborn, W. D. Woodman, E. B. Smith, all of Laconia; O. M. Smith, of Wimesquam; W. B. Fellows, attorney, Tilton.

SHERBURNE, MINN.—The Sherburne Electric Light Company, of Sherburne, has been incorporated to generate and furnish electricity. Capital, $15,000; incorporators: F. H. Brundage, E. Brundage, both of Malta, Ill.; D. M. Reynolds, F. R. Brundage, J. McGovern, G. R. Harnden, W. F. Brundage, all of Sherburne.

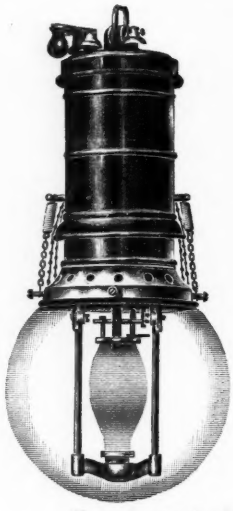
GREENSBURG, IND.—The Greensburg Telephone Company has filed articles of incorporation with the Secretary of State. Capital stock, $30,000. The incorporators are: Alfred P. Bone, W. B. Hamilton and David A. Myers. The company is to operate in Decatur, Franklin, Rush, Shelby, Bartholomew, Jennings, Ripley and Dearborn counties.

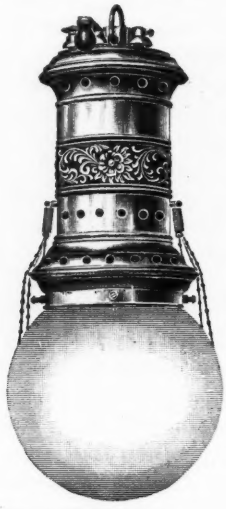
KANSAS CITY, MO.—Articles of incorporation of the Howard Electric Company were filed recently. The capital stock is $20,000, divided into 200 shares. The incorporators are: James H. Howard, Kansas City, Kas., 68 shares; W. F. Voigt, Kansas City, Kas., 60 shares; W. P. Robinson, Jr., one share; W. L. Poffenbarger, 70 shares, and E. L. Massie, one share.

SOUTH MCALESTER, IND. TER.—Articles of incorporation have been filed by the Union Electric Railway Company, with principal offices at South McAlester, I. T. The corporation is capitalized at $122,000, and the directors are: Albert H. Howe, of New York city; Eugene E. White, William G. Weimer, William F. Browne, J. F. Craig, South McAlester, I. T.; William Wingfield, Robert E. Wood, Shawnee, Okla.; Eugene T. White, Fort Sill, Okla. The corporation is to exist for 99 years.

CROSS FORK, PA.—The Cross Fork, Germania & Galeton Telephone Association, of Cross Fork, has been incorporated to construct and operate telephone lines. Capital, $3,000; incorporators: Lackawanna Lumber Company, Pennsylvania Stove Company, both of Cross Fork; H. Schwarzenbach, of Germania; A. C. Green, of Wellsville, N. Y.; W. F. Rice, of West Branch.

NYACK, N. Y.—The Rockland County Traction Company has been incorporated. Its length is 30 miles, entirely within Rockland County, with termini at Upper Nyack and Rockland Lake, and running through the villages of Nyack, South Nyack, Piermont and New City. The principal office is to be at Nyack, and its capital is $300,000. Its directors are: Charles W. Reeve, Franklin H. Reeve, George F. Carpenter, George M. Carpenter, Samuel A. Osborn, of Brooklyn; Ethelbert D. Harris, Henry F. Shields, of New York city; Frederick Stillwell, of Hackensack, N. J., and John W. Dalley, of Nyack.





FIGS. 1 AND 2.—NEW DIRECT-CURRENT ARC LAMPS.

New Direct-Current Arc Lamps.

The Falcon Electric Manufacturing Company, of New York city, has just brought out a new line of direct-current arc lamps, two of which are shown in the illustrations herewith. These are made in a waterproof Japan finish, or in a polished brass finish, and are furnished with either clear or opal globes. The weight of the lamp without glass is 15 pounds, and the diameter of the globe is 11 inches. The current consumption is arranged for four or five amperes and with a solid upper carbon, one-half by twelve inches, and a solid lower carbon one-half by five inches, the life of the lamp is 180 hours. The workmanship of these lamps is very high class, and the selling price of the lamp includes the royalty paid by the manufacturers for the protection of their customers.

The American Electrical Works' Clambake.

Over 400 guests accepted the invitation of Mr. Eugene F. Phillips, general manager of the American Electrical Works, and were present at the twenty-second annual clambake given by that company at the Pomham Club, Providence, R. I., on Thursday, September 13. The bake was one of the most successful of the many that have been given by Mr. Phillips—which are recognized as an important part of the year's events by the electrical fraternity in general.

The American Electrical Works is one of the pioneer wire manufacturers in the electrical field, and many years ago started the custom of giving once a year a dinner to its many friends and customers. This custom has grown to be so well recognized among the trade that it is looked forward to with much pleasure by many who have the opportunity of attending the bakes, and all who do attend are sure of a cordial welcome and a pleasant time. No expense was spared by Mr. Phillips to make the affair a memorable and enjoyable one for his guests, and the situation of the Pomham Club affords the opportunity for doing this. The bowling alleys, billiard rooms, etc., were at the service of any whose tastes lay in that direction.

The ball game held in the morning between picked teams of experienced players from among the electrical men caused much interest. Liquid refreshments were served all the time. Lunch was served at 11.30, and at two o'clock the bake proper commenced, where the chef outdid himself in the way of refreshments and sea food.

After dinner Mr. Phillips made an address welcoming all to the twenty-second annual clambake. This was answered by Mr. T. D. Lockwood, who acted as toastmaster and also responded to a toast on the telephone. Professor Elisha Gray gave a very interesting and amusing speech on the telegraph, during which he told several laughable anecdotes of things that had happened during his long experience in that line. Mr. D. J. Hayden answered a toast to the city of Providence, and Colonel Van Slyck upheld the profession of the lawyers by a short history of that profession. Mr. J. M. Wakeman responded to a toast on the press. Major R. S. Brown, together with Mr. Townsend, gave very forcible speeches on the subject of power transmission. The speeches ended with an address by Mr. Lockwood thanking Mr. Phillips for his hospitality, which was seconded by all present with three cheers.

Each of the guests present received an extremely handsome as well as useful souvenir in the shape of a highly burnished copper match safe embossed with the trade mark of the American Electrical Works.

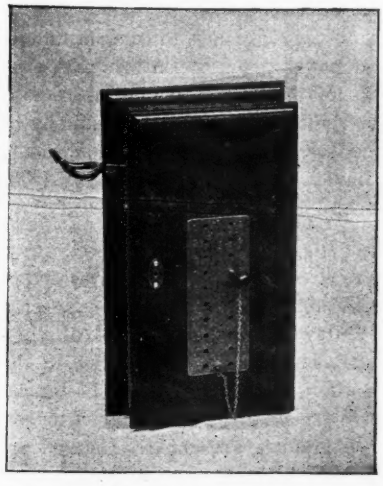


FIG. 1.—AUTOMATIC TELEPHONE SWITCH BOX.

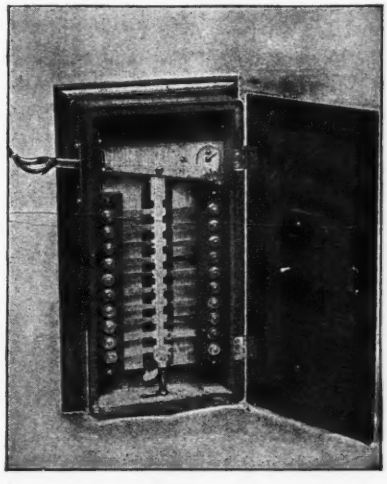


FIG. 2.—INTERIOR OF AUTOMATIC TELEPHONE SWITCH BOX

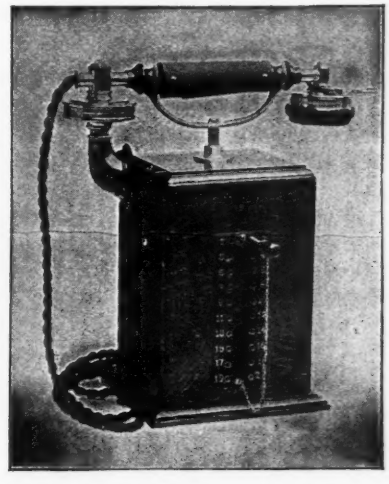


FIG. 3.—DESK SET WITH AUTOMATIC SWITCH.

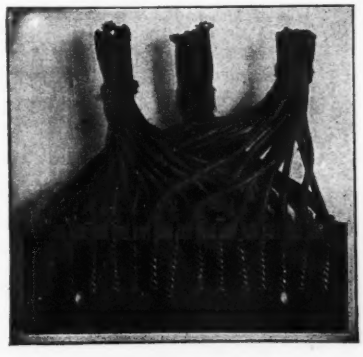


FIG. 4.—JUNCTION BOX FOR INTERIOR TELEPHONE SYSTEM.

An Automatic Interior Telephone System.

The illustrations shown herewith represent various apparatus used in connection with an interior telephone system, operating through an automatic switch, the whole being manufactured by the Globe Telephone Manufacturing Company, of Philadelphia.

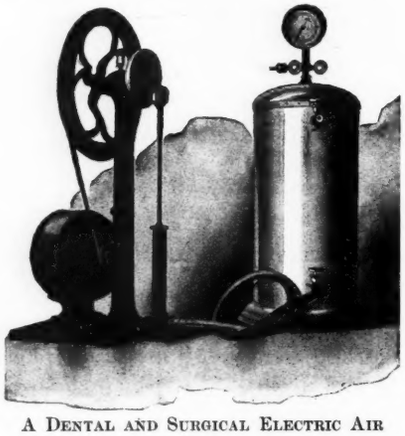
Fig. 1 shows an exterior view of an automatic switch for 16 stations. The object of the invention was to provide against the accidental or unintentional leaving of the circuit open by failure of the user to return or to replace the switch lever in its initial position contact. Even when a spring is used to accomplish this purpose it is liable to lose its tension, and the switch lever is also liable to become clogged or "stuck" at some point when released by the hand. At the same time this switch permits several telephones to be spoken to simultaneously from any station. In operating the instrument, the pin is put into the properly numbered hole corresponding to the desired station at the time of taking the receiver from the hook. When the telephone is out of use the switch lever is necessarily always in its initial position, being retained therein by the weight of the telephone receiver which the user is compelled to hang upon the hook as the only way of properly disposing of it. Fig. 2 gives an interior view of a similar box. It will be observed that there are no wires or contact points on the door of the box in which the switch is mounted, and its operation is exceedingly simple and perfectly evident from the illustration. Fig. 3 shows a desk set with this automatic switch and a combination receiver and transmitter, the whole apparatus being entirely automatic. Fig. 4 shows a junction or splicing box made for use with this system or other house-wiring systems. By its use one wire from each section of the cable is put into the same slot and twisted together. The slots keep the splices apart, thus avoiding the necessity for use of tape and making it very easy to trace trouble.

Recent Electrical Patents

A novel method of treating scrap tin for the purpose of effecting the complete dissociation and separate recovery of the iron and tin present in scrap tin-plate and, incidentally, to secure in commercial quantities as a by-product a nitrate of the alkali metal or alkaline-earth metal the nitrate of which forms the base of the electrolyte employed, has been patented by Edward D. Kendall, of New York, N. Y. The invention is an electrolytic process and in carrying the same into practice, there is prepared an electrolyte consisting of an aqueous solution containing five per cent, more or less, by weight, of the nitrate selected. The solution is usually filtered and is then introduced into an electrolytic vat, which may have any desired form or size. In appropriate relation to the electrolyte and in any desired position or positions there is arranged a plate or plates of carbon or of tin or other metal coated with tin to serve as the cathode. The scrap tin plate to be operated upon, which may or may not have been passed through corrugating-rolls, is loosely packed to form a mass, which is submerged in the electrolyte and made to serve as the anode by connection in the usual manner with one terminal of a charged electric circuit, the cathode being electrically connected with the other terminal of said circuit. The results are the formation of stannic oxide in the form of a solid precipitate, a portion of which on coming in contact with the cathode will be reduced to metallic tin. A further result is the reduction to a nitrate of the sodium nitrate or other nitrate originally contained in the electrolyte. After using the electrolyte until it ceases to act with the desired energy enough of the nitrate (as sodium nitrate) is added to restore efficiency to the solution. By such repeated addition the solution finally becomes heavily charged with sodium nitrate and usually contains a small proportionate quantity of unchanged nitrate and also some ammonia resulting from the electrolytic decomposition of the nitrate. It may also contain traces of tin, which may be recovered by electrolysis when deemed expedient. This strong solution of sodium nitrate is conducted to any suitable evaporating plant in which the water present is driven off, leaving as a residuum the salts from the solution in a solid form available for use as a source of nitrogen in the preparation of agricultural fertilizers.

A Dental and Surgical Electric Air Pump.

The ingenious little combination shown in the accompanying illustration is intended for the use of physicians, surgeons and dentists or for any uses where a small supply of compressed air at moderate pressure is desirable. It consists of a single-acting piston or pump with metallic ball valves operating by a single-phase alternating-current motor and connected by a short length of pressure hose to a six-gallon tank supplied with a gauge to show pressure, and special case and hose connections for leading off the compressed air to atomizers, etc. The pump will compress air up to about 30 pounds, but it is intended to be used at an average of about



A Dental and Surgical Electric Air Pump.

20 pounds pressure, which is usual for the class of work for which it is intended. The pump will fill the tank to a pressure of 20 pounds in a little over six minutes, and is quite sufficient in capacity to maintain this pressure under ordinary use given it by a surgeon or dentist. The apparatus as shown is manufactured by the Emerson Electric Manufacturing Company, of St. Louis, Mo.

Sacrifice Sale of a Vermont Trolley Road.

At the sale of the Bennington, Vt., & Woodford Electric Railroad last week, the power station and equipment brought $680, and the furniture, supplies, etc., went to different parties for $500. The original cost of the property sold was over $30,000. The road was built in 1895 and is nine miles in length. Since the freshet of 1898 has not been used, as it was damaged at that time to a great extent, and has never been repaired. It is reported that New York parties have an eye on the road, and that before another year it may pass into new hands.

Electric Lighting

In the new addition to the electric light plant at Naperville, Ill., there is to be installed one 120-kilowatt Warren alternator and marble switchboard, a 300 horse-power cross-compound Corliss engine and several other improvements on which considerable money will be spent.

A 50-year franchise to conduct an electrical power plant to furnish power and lights to mines and the unincorporated towns of this county, has been sold by the supervisors of Redding, Cal., to Alexander H. Davidson, of San Mateo County. The franchise is not exclusive.

Mr. Horatio A. Foster, the well-known electrical engineer of Buffalo, has accepted the position of consulting engineer of the Railways Company General, of Philadelphia, and will make his home in that city after this month. Mr. Foster has been engaged during this Summer in work for the Railways Company General and other Philadelphia companies.

The big $6,000,000 mortgage of the South Jersey Gas, Electric and Traction Company, the merger of nearly all the gas and electric light plants and trolley roads in Burlington, Camden and Gloucester Counties, N. J., has been filed in the clerk's office, at Woodbury, and is being recorded. This instrument covers 45 pages of printed matter and bears three $1,000 revenue stamps.

Fifteen hundred men are rushing to completion the longest and largest electric transmission plant in the world, by means of which the water from the mountain lakes and streams of the Sierras will be made to furnish power to the cities of San Francisco, Oakland, San Jose and Stockton, Cal. The voltage produced will be 60,000 (the highest in the world), and 14,000 horse-power will be supplied constantly over 180 miles of double wire.

News comes from Chihuahua, in Mexico, that a former American consul has promoted a scheme for the generation of power on the San Juan branch of the Concho River. The company has been incorporated under the laws of Illinois, with a capital of $1,000,000, and when the work is completed it is estimated that 6,000 to 10,000 horse-power can be produced. The electric energy will be transmitted to Peral, 40 miles, and to Chihuahua, 80 miles.

Feed-Water Heaters and Purifiers.

It has long been recognized that a considerable saving, ranging from 5 to 20 per cent or more, may be accomplished by the use of properly designed exhaust steam feed water heaters, even when a plant is equipped with economizers and provided with live steam purifiers. At the same time there is an element of insurance in the use of feed water heaters, since they eliminate the strains due to the introduction of cold water into the boiler.

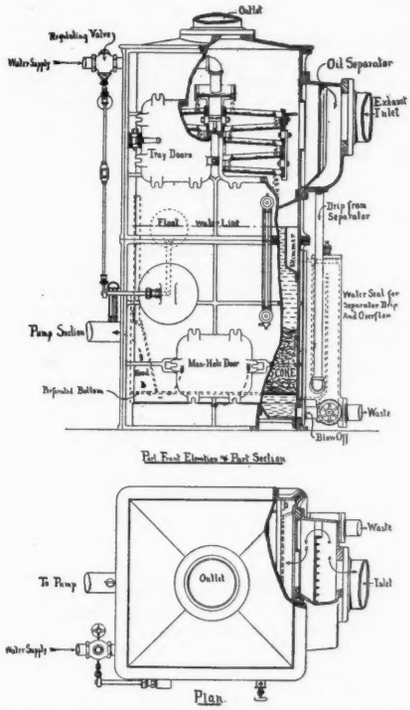


FIG. 1.—SECTIONAL ELEVATION AND PLAN OF A FEED-WATER HEATER AND PURIFIER.

The feed water heaters here illustrated are those manufactured by the Harrison Safety Boiler Works, of Philadelphia, Pa., and known as the Cochrane heaters. These heaters belong to what is called the open or direct-contact type, wherein the exhaust steam is brought into actual physical contact with the water to be heated. The construction of the size intended for 500 horse-power or upward may readily be seen from Fig. 1, which shows such a heater in vertical section and in plan. The exhaust steam enters the heater through an oil separator bolted to the outside of the shell. This separator is self-cleaning and is drained through a drip pipe connected to the water seal on the waste pipe. The upper portion of the heater contains removable and interchangeable trays which vary in number and arrangement according to the size of the heater. These are inclined and the edge over which the water flows is serrated or saw-toothed for breaking up the water into drops. These trays are so held in place that the pulsations of the exhaust can not dislodge them, though they may readily be removed through the cleaning door openings. The cold water is introduced at the top of this set of trays and trickles down over them coming thoroughly into contact with the hot exhaust steam. Outside of the heater, on the cold water inlet pipe, is placed a disk or balanced valve for regulating the cold water supply. This valve is controlled by a copper float carried in the heater, as the illustration well shows. Just above the working level of the water, in the lower part of the heater, is placed a skimmer. The bottom of the heater contains a filter bed which effectually removes the last traces of foreign matter from the feed water before it is taken into the boiler.

Fig. 2 illustrates a right-hand heater having an outside float box equipment, and Fig. 3 shows a 10,000 horse-power heater built on the principles described above.

TUTTLETOWN, CAL.—The Tuttletown & Angels Aerial Tramway Company has been incorporated by A. Poniatowski, S. D. Freshman, William Angus, Wellington Greeg, Sr., and E. P. O'Brien, with a capital stock of $100,000, of which amount they subscribed $2,500. The aerial tramway which the company will construct will extend from a point near Tuttletown, Tuolumne County, to Angels, Calaveras County, a distance of eight miles, and will be used for carrying passengers and freight. It will connect with the Sierra Railway Company's road near Tuttletown.

Telegraphone Patent Rights.

United States Consul Worman writes from Munich, August 4, 1900, that he has received inquiries from several parties in the United States as to the patent rights for the telegraphone, the owners thereof, etc. The Bank für Handel and Industrie, of Berlin, says Mr. Worman, represents the syndicate which controls the patents for this device. The managers have informed him that the patent rights in the United States have already been disposed of. The letter adds: "We thank you most sincerely for your kind offer to assist us by your personal cooperation in the development of the telegraphone patents. We regret to have to inform you that we are not in a position to give you the exact information that you desire, as our attempts to produce the telegraphone in the highest possible perfection have not yet been successful."

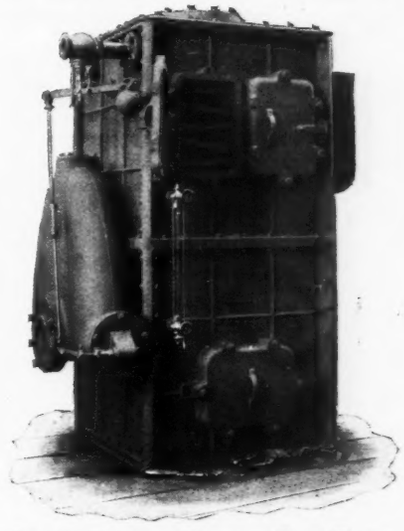


FIG. 2.—EXTERIOR VIEW OF FEED-WATER HEATER AND PURIFIER.

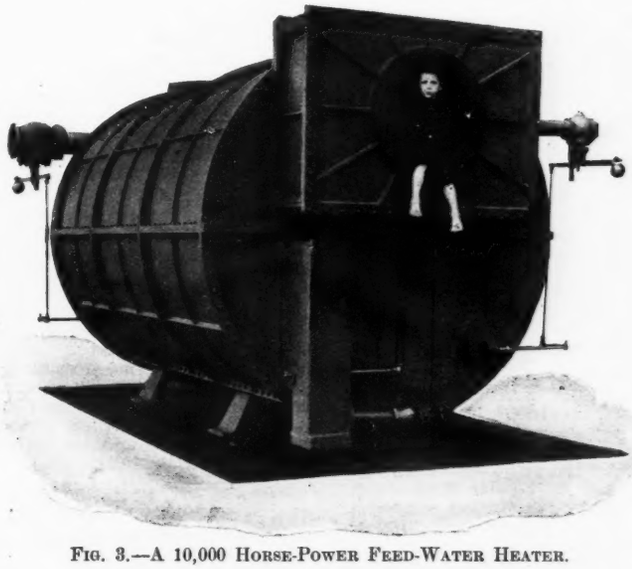


FIG. 3.—A 10,000 HORSE-POWER FEED-WATER HEATER.

Industrial Notes

THE BABCOCK & WILCOX COMPANY, New York city, informs the ELECTRICAL REVIEW that its boilers have been awarded the Grand Prix at the Paris Exposition.

TWO LARGE SHIPMENTS of Cross oil filters were made by the Burt Manufacturing Company, of Akron, Ohio, to France during the month of July, as the direct result of their exhibit at the Paris Exposition.

E. B. LATHAM & COMPANY, 136 Liberty street, New York, announce the completion of their catalogue No. 17, showing complete lines of electric bells, house goods supplies, batteries, telephone, telegraph, electric fan apparatus and general electrical supplies.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., is sending to its customers and others numerous bulletins for insertion in its perpetual catalogue. As rapidly as this company prepares new apparatus it is described in a bulletin which is forwarded for filing with its catalogue.

THE CHICAGO FUSE WIRE AND MANUFACTURING COMPANY, of Chicago, has been officially notified that a medal has been awarded to it by the International Jury of Awards for its exhibit at the Paris Exposition. The exhibit consists of a complete showing of the company's "trade-mark" line of tested fuse wires and fuse links.

THE NATIONAL CARBON COMPANY, Cleveland, Ohio, wishes to announce that it guarantees as superior to any imported carbon the Columbia carbons for enclosed and open arcs, and that the guarantee is indorsed to the extent that the carbons proving unsatisfactory may be returned at its expense. The Columbia carbons are made in all sizes, both cored and solid, for direct and alternating currents.

AT THE RECENT AUTOMOBILE RACES, held at Aquidneck Park, near Newport, R. I., a De Dion-Bouton motor tricycle, ridden by Mr. Kenneth A. Skinner,, developed extraordinary speed. Mr. Skinner won the five-mile race, his time being 10 minutes and 30½ seconds. The next man made the time of 11 minutes and 40 seconds. The De Dion vehicles are manufactured by the De Dion-Bouton Motorette Company, of Brooklyn, N. Y.

MANY USERS of woven wire dynamo brushes have found great satisfaction in the dynamo brushes that are being manufactured by the Crown Woven Wire Brush Company, Salem, Mass. These brushes are carefully put together and finely finished and are particularly adapted for use on high-class dynamos and motors. They prevent sparking of the dynamo to a great degree and save a large amount of wear on the commutator.

H. W. McCANDLESS & COMPANY, 79 Cortlandt street, New York, have recently published a complete and artistic catalogue of miniature and special incandescent lamps, of which they are the manufacturers. This company carries in its regular stock a sufficient supply so that demands may be promptly met. One of the unique specialties described in the catalogue is a combination of candelabra lamps and white glass candle tips mounted on a standard Edison or T.-H. lamp base.

THE EUREKA ELECTRIC COMPANY, Chicago, reports the most unprecedented success of its new No. 1 special transmitter, which is being tested by some of the most representative telephone companies. The Eureka company reports a very large number of orders and the absolute satisfaction this transmitter is giving. At the present time the company has in press what, it is said, will be the largest catalogue issued to date in the independent telephone field. It will describe the company's very large and exclusive line of high-grade telephones and switchboards, as well as instruments and parts. The Eureka Electric Company will be pleased to furnish these catalogues, upon application, to any company interested.

COLLINS ELECTRIC COMPANY, Scranton, Pa., is now completing the construction of the company's electric vehicles made under the patents of Mr. B. J. Collins. This company is giving special attention to electric delivery wagons and a delivery wagon of the Collins type has just been completed which weighs only 2,000 pounds with the batteries in position. On one charge of the battery the vehicle is claimed to travel 60 miles over ordinary roads or city streets, and is adapted for a speed of about 12 miles an hour.

THE NATIONAL AUTOMOBILE AND ELECTRIC COMPANY, Indianapolis, Ind., is just introducing a new electric vehicle known as the "New York trap." This vehicle is artistically and rigidly constructed, and is equipped with a two and one-half horse-power motor, geared to the rear hub with a compensating gear in the motor shaft. It is claimed to have a radius of 50 miles on one charge of battery. The officers of this company are: L. S. Dow, president; A. C. Newby, vice-president, and T. R. Goetz, secretary and treasurer.

BINNEY & SMITH, 81-83 Fulton street, New York, inform the ELECTRICAL REVIEW that they have received notification that the jury of awards for the Paris Exposition has awarded them the gold medal for their exhibit of carbons. In the exhibition case the company showed enclosed arc carbons of the different manufacturers in the United States, which had been made out of the crude carbon produced by this company. They also had samples of carbons to be used for insulating purposes and for coating tapes and wires used for electrical purposes.

THE INCANDESCENT ELECTRIC LIGHT MANIPULATOR COMPANY, 116 Bedford street, Boston, Mass., maker of a unique apparatus for cleaning and renewing incandescent lamps in inaccessible places, announces that it has received the following letter: "I beg to inform you that the International Jury of Award has granted a bronze medal to your exhibit (of manipulators) in this department." The company announces that on the day it was in receipt of this letter orders from Cuba, British Columbia, Canada, California, New York and other nearer-home customers were received.

THE PERU ELECTRIC MANUFACTURING COMPANY, Peru, Ind., according to a recent interview with its sales manager, Mr. F. H. Schlesinger, is receiving such heavy orders for its standard lines of porcelain specialties that the factory is running to its utmost capacity. This company manufactures a new rosette called the "Pemco" which is being generally adopted, as it is especially made for moulding work. The company is also manufacturing porcelain transformer fuse plugs and a complete line of the new Peru branch cut-out, which embodies a new patented porcelain fusible plug.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, Philadelphia, Pa., announces that it is manufacturing a full line of shunt ammeters, for direct-current switchboard use, in its type "K" illuminated dial, type "K" and type "R" cases. These shunt ammeters are designed for use under conditions where series ammeters could not meet all requirements, as in the case of the combined use of dynamo and storage battery, the measurement of charge and discharge of storage batteries and for the measurement of current in excess of 1,500 amperes. The scales are equally divided from zero to maximum reading. The meters are demonstrated to be light, but strong, and to accomplish the highest obtainable efficiency and sensibility, and the manufacturers guarantee their accuracy, constancy and durability.

A COURSE OF INSTRUCTION by mail in chemistry is announced by the International Correspondence Schools, Scranton, Pa. The course includes mathematics, physics, theoretical, inorganic and organic chemistry, qualitative and quantitative analysis. George Herman Dimpfel, Ph. D., who is in charge of the chemistry course, is a graduate of the University of Leipsic, Germany, and also studied in the universities of Strassburg and Heidelberg. Later he was an instructor in the latter institution, but was induced to take up commercial work, and, after an extended experience in European cities, he came to this country and is now principal of the school of chemistry.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Green and Congress streets, Chicago, has issued Bulletin No. 1, a very handsome piece of printing, describing its well-known telephone apparatus. The illustrations are of unusual excellence, the arrangement of the bulletin is very convenient, and the descriptive matter is simple and attractive. The same company has also issued a pamphlet describing the history of the company, as well as its manufacturing plants in their various details. This booklet is of an unusually attractive character and the cover is printed in colors and gold. Both publications may be obtained on application by those interested.

THE AMERICAN ELECTRIC FUSE COMPANY, 345-347 South Canal street, Chicago, Ill., manufacturer of fuse blocks, fuses, fuse wire, lightning arresters and telephone specialties, has opened a branch office and stock rooms at 116 Nassau street, New York. This office will be under the charge of Mr. W. B. McCurdy, who has been connected with this company for several years and who is particularly well versed in matters relating to the company's line of business. The company will carry in the New York office a complete stock of all goods manufactured or handled, and shipments may be made direct to customers ordering through the New York office. It is believed by the company that this will save both time and money to its patrons, as the question of freight and express charges will be minimized and the time required for transit lessened. Mr. McCurdy will devote his entire attention to the management of the company's affairs.

THE SIMPLEX ELECTRICAL COMPANY, Cambridgeport, Mass., through its heating department has just issued a new catalogue of electric heating apparatus. Referring to the new catalogue, the company states: "This is the sixth catalogue we have issued descriptive of miscellaneous electric heating apparatus, which indicates by comparison with previous issues, the steady growth of our electric heating business. Four years ago a catalogue of 20 pages was sufficient, while the present one is nearly 60 pages, covering more than 10 times as many items as described then. Many successful kitchen outfits have demonstrated that in the very near future all good apartment houses will be provided only with electricity for cooking and ironing. Many hotels, hospitals, sanitariums and steamships use electric flat-irons, griddles, broilers, toasters, hot-water urns and other items to a considerable extent. Tailors, clothing manufacturers, laundries, etc., use thousands of irons, making necessary the large variety listed. Electric heaters for street cars are now the only kind considered, and we make 14 styles to meet the requirements in this line. These are described in a separate catalogue. Our product of special electric heating apparatus is a very considerable item. Radical improvements in quality of product, combined with a wider use of electric current, have made possible the rapid growth of this branch of electric development."